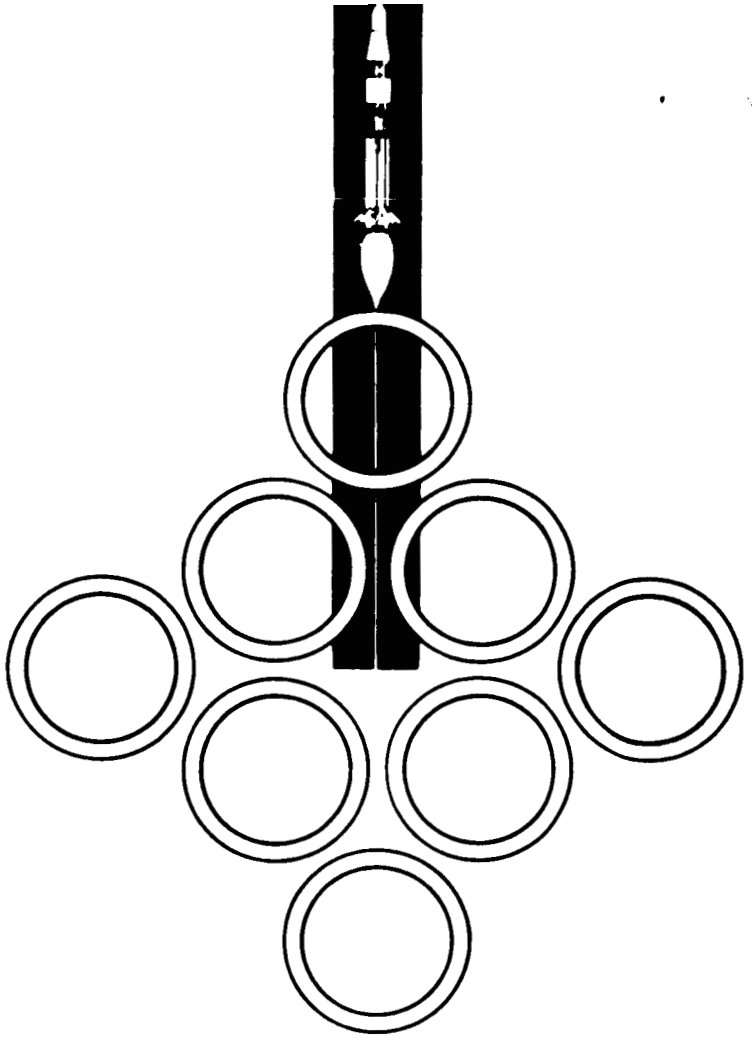


ENGINEERING DEPARTMENT

TECHNICAL REPORT

TR-RE-CCSD-FO-1124-3

May 1, 1967

SATURN IB PROGRAM

TEST REPORT
FOR

ANGLE VALVE, 1/2-INCH

Combination Pump and Valve Co. Model 371, Drawing Number C-6480

NASA Drawing Number 10428534

SPACE DIVISION CHRYSLER CORPORATION

TEST REPORT

FOR

ANGLE VALVE, 1/2-INCH

Combination Pump and Valve Co. Model 371, Drawing Number C-6480

NASA Drawing Number 10428534

ABSTRACT

This report presents the results of tests performed on one specimen of the Angle Valve 10428534. The following tests were performed:

1. Receiving Inspection
2. Proof Pressure
3. Functional
4. Flow
5. Surge
6. Low Temperature
7. High Temperature
8. Life Cycle
9. Burst

The specimen's performance was in accordance with the specification requirements of NASA Drawing Number 10428534, except during burst testing.

During burst testing, the valve failed at 18,900 psig. The specification requirements were that the valve withstand a minimum burst pressure of 24,000 psig.

TEST REPORT

FOR

ANGLE VALVE, 1/2-INCH

Combination Pump and Valve Co. Model 371, Drawing Number C-6480

NASA Drawing Number 10428534

May 1, 1967

CHRYSLER CORPORATION SPACE DIVISION - NEW ORLEANS, LOUISIANA

FOREWORD

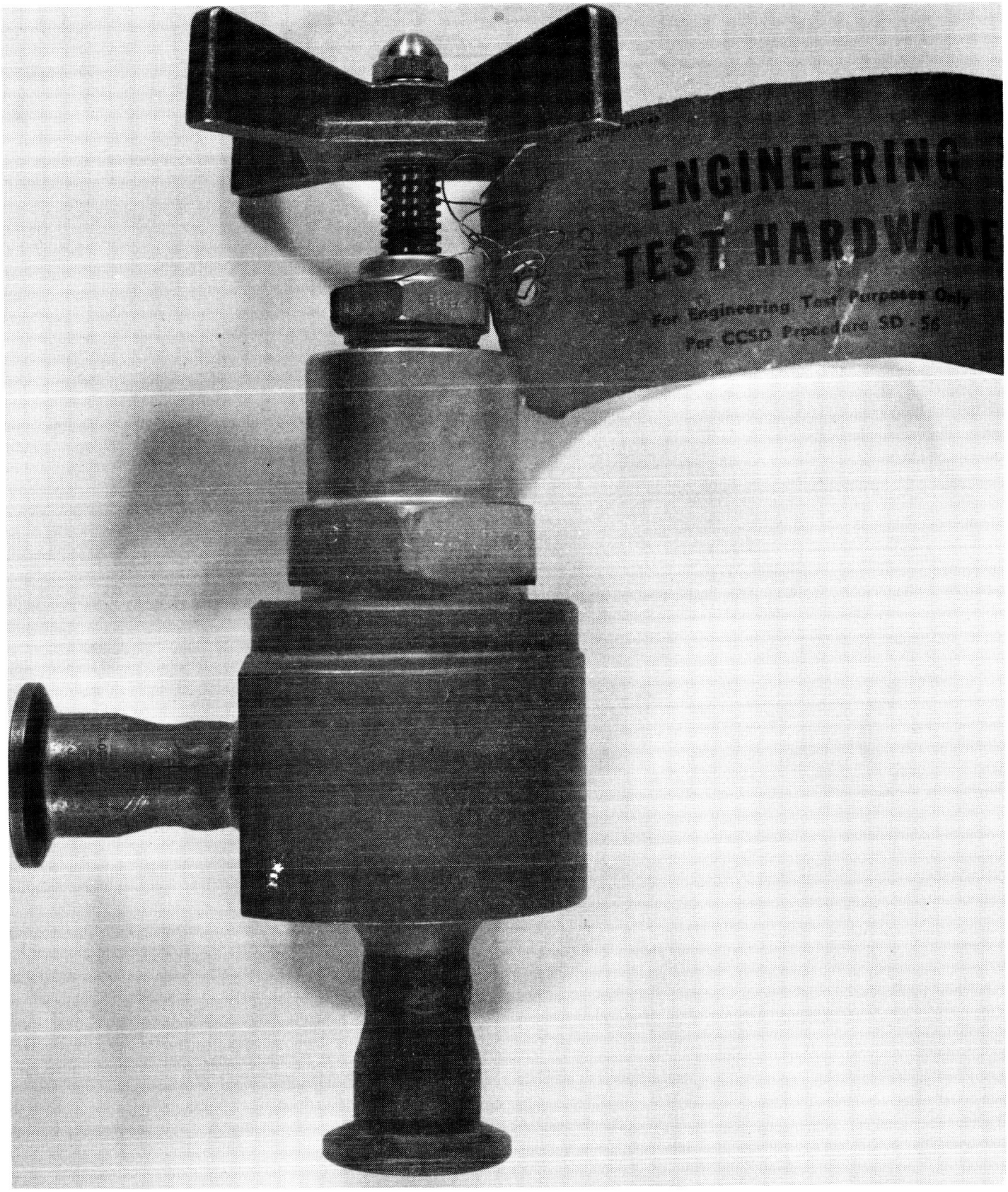
The tests reported herein were conducted for the John F. Kennedy Space Center by Chrysler Corporation Space Division (CCSD), New Orleans, Louisiana. This document was prepared by CCSD under contract NAS 8-4016, Part VII, CWO 271620.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

LIST OF TABLES (CONTINUED)



Angle Valve 10428543

CHECK SHEET

FOR

ANGLE VALVE, 1/2-INCH

MANUFACTURER: Combination Pump and Valve Co.
MANUFACTURER'S MODEL NUMBER: 371
MANUFACTURER'S DRAWING NUMBER: C6480
NASA DRAWING NUMBER: 10428534
TESTING AGENCY: Chrysler Corporation Space Division, New Orleans, Louisiana
AUTHORIZING AGENCY: NASA KSC

I. FUNCTIONAL REQUIREMENTS

A.	OPERATING MEDIUM:	He or GN_2
B.	OPERATING PRESSURE:	6000 psig
C.	PROOF PRESSURE:	9000 psig
D.	BURST PRESSURE:	24,000 psig
E.	VALVE CAPACITY:	(C_v) = Average of 1.1 over a range of 2 to 9 gpm
F.	LEAKAGE:	Bubble tight below 6000 psig
G.	TORQUE:	
1.	Desired valve stem maximum -	100 in-lbs
2.	Breakaway -	150 in-lb (determined by test)
3.	Running -	150 in-lb (determined by test)
4.	Seating -	150 in-lb (determined by test)

II. CONSTRUCTION

A.	BODY MATERIAL:	316 stainless passivated per 5.4.1 of MIL-STD-171
B.	SEAT MATERIAL:	Monel QQ-N-281 CLA, Teflon disc
C.	OUTLET PORT:	½ inch, SCH. XXX, Grayloc clamp type
D.	INLET PORT:	½ inch, SCH. XXX, Grayloc clamp type
E.	SECTIONAL DIMENSIONS:	Drawing 10428534

III. ENVIRONMENTAL REQUIREMENTS

A.	OPERATING TEMPERATURE:	+5 to +160°F

IV. LOCATION AND USE:

Saturn IB Ground Support Equipment, Launch Complex 34 Pneumatic System, as a shutoff valve for GN_2 or He.

TEST SUMMARY

ANGLE VALVE, ½-INCH, 10428534

Environment	Operational Boundary	Test Objective	Units	Test Results	Remarks
Receiving Inspection	NASA Drawing No. 10428534	Visual and dimensional examination for compliance	1	Satisfactory	No visual deviations from the specification or good workmanship
Proof Pressure	9000 psig for five minutes	Check for leakage or distortion	1	Satisfactory	No leakage or distortion
Functional Test	Leakage: Bubble tight at 6000 psig	Check for leakage and establish opening and closing and running torque values	1	Satisfactory	No leakage Torque values: Opening - 150 in-lb Running - 150 in-lb Closing - 150 in-lb
Flow Test	Desired C_v is average of 1.1 over a range of 2 to 9 gpm	Determine C_v for the valve	1	Satisfactory	A C_v of 1.1 was found between 2 and 9 gpm.
Surge Test	0 to 6000 psig in 100-milliseconds. 10 cycles with valve closed, and 10 cycles with valve partially open	Determine if specimen operation is impaired by surge	1	Satisfactory	No leakage or apparent distortion due to surge
Low Temperature Test	+5 (+0, -4)°F	Determine if the environments cause degradation or deformation	1	Satisfactory	No leakage or apparent distortion due to thermal change
High Temperature Test	+160 (+4, -4)°F		1	Satisfactory	
Cycle Test	Operating the specimen for 1000 complete cycles with 6000 psig on inlet to valve	Determine if the environment cause degradation or distortion due to accumulative wear	1	Satisfactory	No leakage or apparent distortion due to life cycling
Burst Pressure Test	Minimum of 24,000 psig for five minutes	Determine the structural integrity of the specimen	1	Unsatisfactory	The bonnet (cartridge) threads failed at 18,900 psig

SECTION I

INTRODUCTION

1.1 SCOPE

1.1.1 This report describes the test of the ½-inch valve 10428534. Tests included were those necessary to determine whether the valve will satisfy the operational and environmental requirements of the John F. Kennedy Space Center.

1.1.2 One specimen was tested.

1.2 ITEM DESCRIPTION

Angle Valve 10428534 has a ½-inch nominal size inlet port. It has a design operating pressure of 6000 psig and is rated for use with nitrogen and helium.

1.3 APPLICABLE DOCUMENTS

The following documents contain the test requirements for Angle Valve 10428534:

a. KSC-STD-164(D), Standard Environmental Test Methods for Ground Support Equipment Installations at Cape Kennedy

b. Component Specification, 10428534

c. Cleanliness Standard, MSFC-STD-164(D)

d. Test Plan, TP-RE-CCSD-FO-1124-1F

SECTION II

RECEIVING INSPECTION

2.1 TEST REQUIREMENTS

The specimen was visually and dimensionally inspected for conformance with the applicable specifications prior to the start of the tests.

2.2 TEST PROCEDURE

A visual and dimensional inspection was made of the specimen to determine compliance with NASA drawing 10428534 and applicable vendor drawings to the extent possible without disassembling the test specimen. At the same time the test specimen was also inspected for poor workmanship and manufacturing defects.

2.3 TEST RESULTS

The specimen complied with NASA drawing 10428534. No evidence of poor workmanship was observed.

2.4 TEST DATA

The data presented in tables 2-1 and 2-2 were recorded during inspection.

Table 2-1. Specimen Specifics

Name	Combination Pump and Valve Company ½-Inch Angle Valve
Size	3/4-inch
Model Number	371-3
Serial Number	None

Table 2-2. Specimen Dimensions

Height, Overall (approx.)	9.0-inches
Grayloc Outside Diameter	1.55-inches
Inlet and Outlet Port Size	0.20-inch
Grayloc Bore Center-line to Bonnet Top (approx.)	4.6-inches
Body Diameter	3.3-inches

SECTION III

PROOF PRESSURE TEST

3.1 TEST REQUIREMENTS

3.1.1 The test specimen shall be subjected to a proof pressure of 9000 psig.

3.1.2 The pressure shall be applied simultaneously to the inlet and outlet ports, with the valve in the open position, and shall be maintained for 5 minutes.

3.1.3 The specimen shall be inspected for leakage and distortion.

3.2 TEST PROCEDURE

3.2.1 The specimen was installed in the test setup as shown in figures 3-1 and 3-3 using the equipment listed in table 3-1.

3.2.2 Regulator 15 was adjusted for zero outlet pressure.

3.2.3 The specimen and hand valves 5, 6, 8, 9, 10, 11 and 24 were opened and the system was filled with de-ionized water. All air was bled from the system.

3.2.4 Hand valves 5, 8, 9, 11 and 24 were closed.

3.2.5 Hand valve 7 was opened, and 3000 psig GN_2 was monitored on gage 14.

3.2.6 Regulator 21 was adjusted until a pressure of between 50 and 100 psig was indicated on gage 15.

3.2.7 Switch 17 was then closed. Solenoid valve 18 opened and pump 19 started operating.

3.2.8 The pump continued to operate until a pressure of 9000 psig was indicated on gage 3. Switch 17 was then opened and the pump stopped.

3.2.9 The 9000 psig pressure was maintained for 5 minutes, and the specimen was checked for leakage.

3.2.10 Hand valves 9, 11, and 24 were opened, the system was vented, and the specimen was then checked for distortion.

3.2.11 All data were recorded.

3.3 TEST RESULTS

3.3.1 The specimen did not leak and there was no evidence of distortion.

3.4 TEST DATA

3.4.1 Test data presented in table 3-2 were recorded during the test.

Table 3-1. Proof Pressure and Burst Test Equipment List

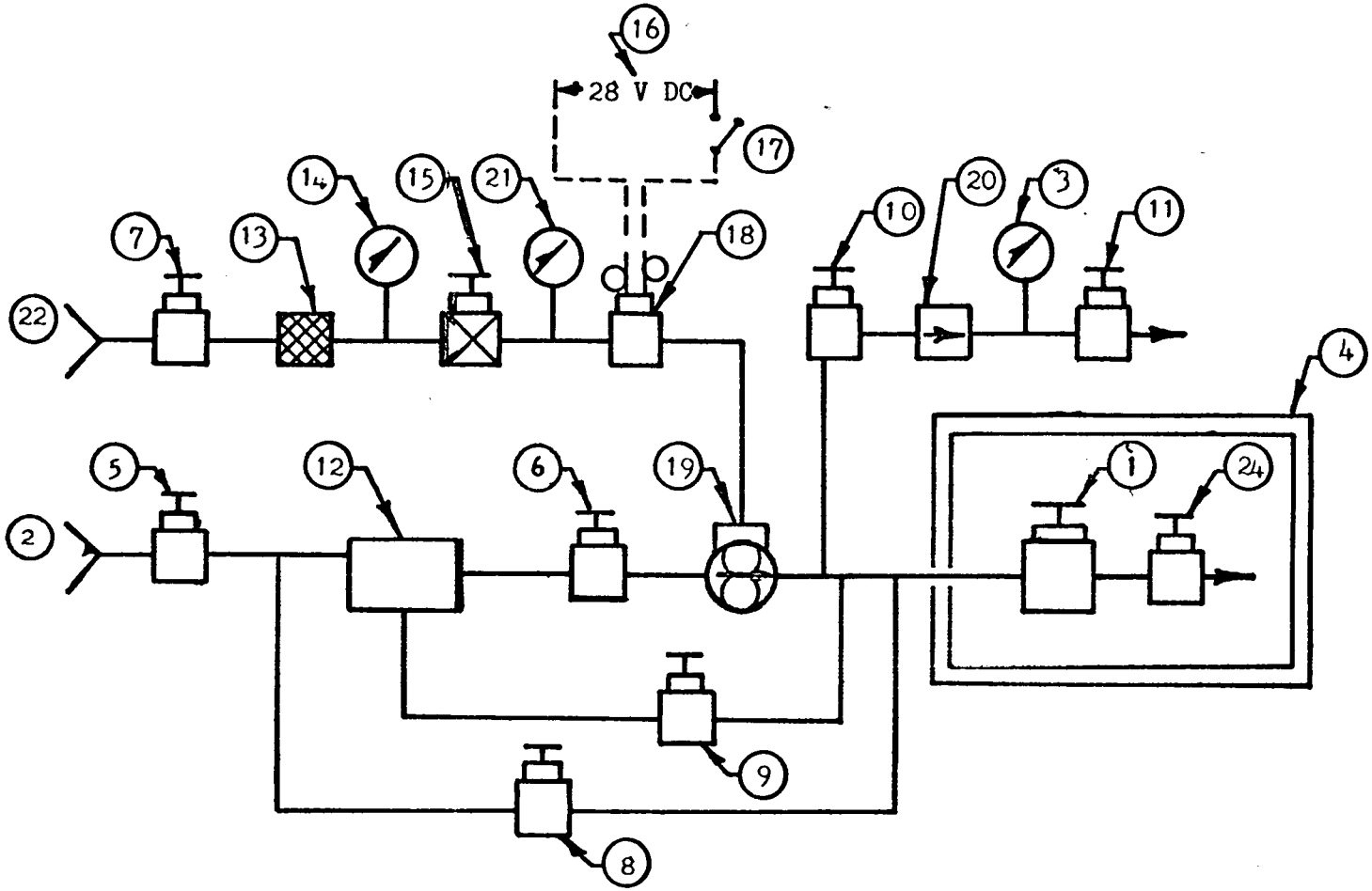
Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Combination Pump and Valve Company	371	NA	Angle valve
2	Water Supply		NA	NA	Tap water
3	Hydrostatic Pressure Gage	Ashcroft	NA	BT-1396 -B	0-to 20,000-psig ±1.0% FS Cal dates 10-1-66 4-1-67
	Hydrostatic Pressure Gage (Burst Test)	Astra	NA	011893-A	0-to 100,000-psig ±2.0% FS Cal dates 11-2-66 4-30-67
4	Burst Chamber	CCSD	NA	201344	3 ft by 3 ft by 3 ft
5	Hand Valve	Aminco	50011A	NA	¼-inch
6	Hand Valve	Aminco	50011A	NA	¼-inch
7	Hand Valve	Aminco	50011A	NA	¼-inch
8	Hand Valve	Aminco	50011A	NA	¼-inch
9	Hand Valve	Aminco	50011A	NA	¼-inch
10	Hand Valve	Aminco	50011A	NA	¼-inch
11	Hand Valve	Aminco	50011A	NA	¼-inch
12	Water Reservoir	CCSD	NA	NA	2-gallon
13	Pneumatic Filter	Bendix Corp.	1731260	NA	2-micron
14	Pressure Gage	Ashcroft	10575	NA	0-to 5000-psig ±2% FS
15	Pressure Gage	USG	8990	NA	0-to 300-psig ±2% FS
16	Power Supply	CCSD	NA	NA	28-vdc
17	Switch	Cutler Hammer	NA	NA	SPST

Table 3-1. Proof Pressure and Burst Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
18	Solenoid Valve	Marotta Valve Co.	207803	NA	2-way, normally closed
19	Hydrostatic Pump	Sprague Engineering Corp.			Air operated; maximum pressure 50,000-psig
20	Check Valve	Aminco	44-6305	NA	¼-inch
21	Regulator	Marotta Valve Co.	NA	NA	3000-psig inlet; 0- to 200-psig outlet
22	GN_2 Pressure Source	Air Products	NA	NA	3000-psig
24	Hand Valve	Aminco	50011A	NA	¼-inch

Table 3-2. Proof Pressure Test Data

Pressure	9,000 psig/5 minutes
Leakage	Zero
Distortion	None



Note: All lines ¼-inch.
Refer to table 3-1 for item identification.

Figure 3-1. Proof Pressure And Burst Test Schematic

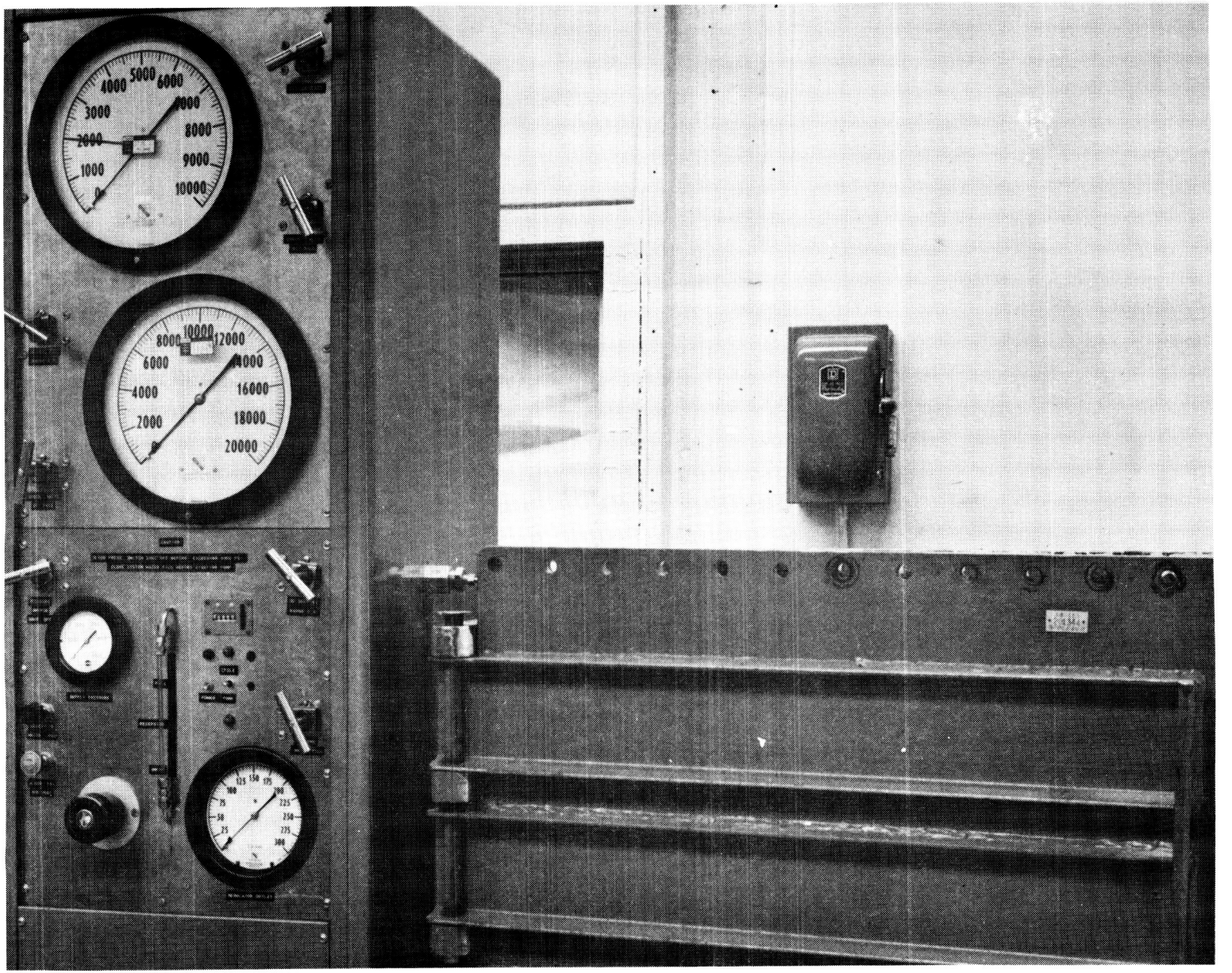


Figure 3-2. Proof Pressure And Burst Test Console

Figure 3-3. Proof Pressure And Burst Test Setup

SECTION IV

FUNCTIONAL TEST

4.1 TEST REQUIREMENTS

4.1.1 The test specimen shall be inspected for leakage with the outlet port of the specimen pressurized to 6000 psig, specimen closed, and the inlet port vented. Leakage shall be recorded.

4.1.2 The test specimen shall be inspected for leakage with the inlet port of the specimen pressurized to 6000 psig, specimen closed, and the outlet port vented. Leakage shall be recorded.

4.1.3 The opening, closing, and normal running torque of the valve shall be determined with the inlet port pressurized to 6000 psig and then relieved to zero psig. Record all data.

4.1.4 Requirements 4.1.1 and 4.1.2 each, shall be repeated once for the initial functional test and performed once for all subsequent functionals. Requirement 4.1.3 shall be performed 10 times initially and 3 times for all subsequent functionals.

4.2 TEST PROCEDURE

4.2.1 The specimen was installed in the test setup as shown in figures 4-1 and 4-2 using the equipment listed in table 4-1 except for thermocouple 18 and thermal chamber 19. All hand valves were closed.

4.2.2 The hand wheel was removed and replaced with valve stem adapter 21 and torque wrench 22. The specimen was closed using a torque of 100 inch-pounds.

4.2.3 All regulators were adjusted for zero outlet pressure.

4.2.4 Hand valves 3 and 8 were opened, and gage 5 was monitored for 7000 psig.

4.2.5 Pressure regulator 7 was adjusted until gage 9 indicated 6000 psig.

4.2.6 Port C on leakage detector 20 was connected to port A of hand valve 16.

4.2.7 Hand valves 12 and 16 were opened. There were no bubbles in leakage detector 20.

4.2.8 Regulator 7 was adjusted for zero outlet pressure, hand valve 17 was opened and the specimen was vented.

4.2.9 Hand valves 16 and 17 were closed and port C of leakage detector 20 was connected to port B of hand valve 17.

4.2.10 Procedures 4.2.5 through 4.2.8 were repeated.

4.2.11 Regulator 7 was slowly adjusted until 6000 psig pressure was applied to the inlet port of the specimen.

4.2.12 The breakaway torque of the specimen was measured by slowly applying the maximum torque required to unseat the specimen.

4.2.13 The specimen was then fully opened. The running torque was then measured between breakaway and open.

4.2.14 The specimen was then closed, and the running torque during closing was measured.

4.2.15 Hand valve 17 was then opened to vent the outlet port of the specimen, and leakage detector 20 was connected to port B of valve 17.

4.2.16 With the pressure on the inlet port of the specimen, the specimen was slowly opened until bubbles appeared in leakage detector 20.

4.2.17 The specimen was slowly closed and the closing torque for the specimen at operating pressure was measured.

4.2.18 Regulator 7 was closed, hand valve 16 was opened and the specimen was vented.

4.2.19 Procedures described in 4.2.12 through 4.2.14 were repeated to determine breakaway and running torque values for the unpressurized specimen.

4.2.20 Hand valves 11, 12, 16 and 17 were closed. Hand valves 10 and 15 were opened, and the regulator 13 was adjusted to establish 2 psig on gage 14.

4.2.21 Hand valve 17 was opened.

4.2.22 The specimen was opened until bubbles appeared in leakage detector 20.

4.2.23 The specimen was slowly closed and the torque required to stop the bubbles was recorded as the reseating torque for unpressurized conditions of the specimen.

4.2.24 Regulators 7 and 13 were adjusted to zero outlet pressure, hand valve 16 was opened and the inlet port of the specimen was vented.

4.2.25 With the specimen unpressurized the valve was closed using the 100 inch-lb torque value. Procedures 4.2.11 through 4.2.24 were repeated ten times and the data recorded in table 4-2.

4.3 TEST RESULTS

The 100 inch-pounds maximum seating torque desired was exceeded. Typical seating torques of 150 inch-pounds were required. A seating torque of 150 inch-pounds was not excessive for this valve and no malfunction or degradation occurred throughout the test.

4.4 TEST DATA

Test data are presented in table 4-2.

Table 4-1. Functional Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Combination Pump and Valve Company	371	NA	½-inch angle valve
2	Helium and Nirtogen Source	CCSD	NA	NA	7000-psig
3	Hand Valve	Combination Pump and Valve Co.	380-3	NA	1½-inch supply
4	Filter	Microporous	4813F-2M	NA	2-micron
5	Pressure Gage	Duragage	NA	NASA	0-to 10,000-psig ±2% FS Cal dates 1-25-67 4-24-67
6	Hand Valve	Robbins Aviation	SSKG-250 -4T	NA	¼-inch
7	Regulator	Tescom Corporation	26-1002	1002	7000-psig inlet 0-to 7000-psig outlet
8	Hand Valve	Robbins Aviation	SSKG-250 -4T	NA	¼-inch
9	Hand Valve	Robbins Aviation	SSKG-250 -4T	NA	¼-inch
10	Hand Valve	Robbins Aviation	SSKG-250 -4T	NA	¼-inch
11	Hand Valve	Robbins Aviation	SSKG-250 -4T	NA	¼-inch
12	Hand Valve	Robbins Aviation	SSKG-250 -4T	NA	¼-inch
13	Regulator	Tescom Corporation	26-1002	1009	100-psig inlet 0-to 10-psig outlet
14	Pressure Gage	Marsh Instrument Company	NA	NASA 08-113-1142B	0-to 30-psig ±0.5% FS Cal dates 1-10-67 4-10-67

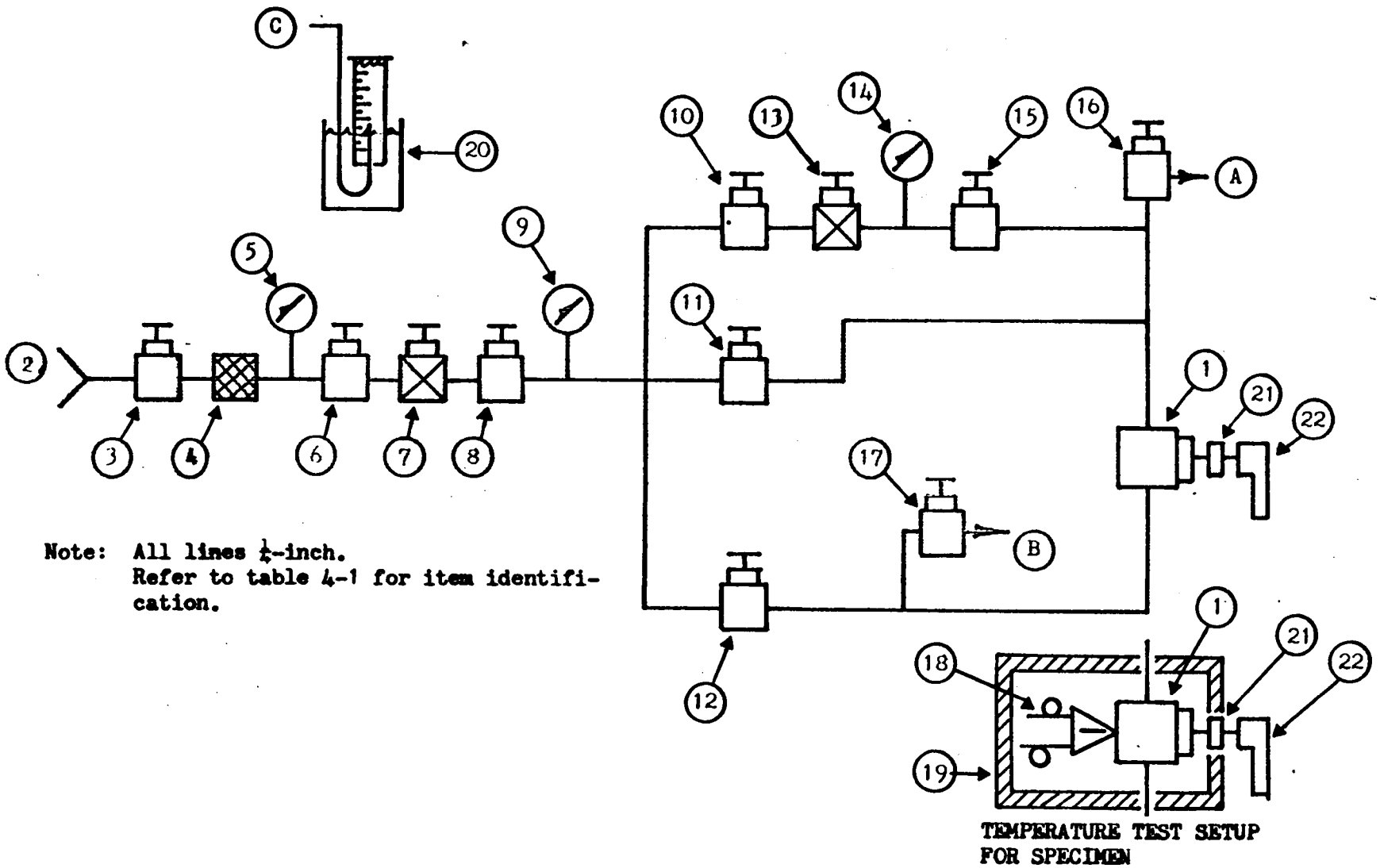
Table 4-1. Functional Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
15	Hand Valve	Robbins Aviation	SSKG-250 -4T	NA	¼-inch
16	Hand Valve	Robbins Aviation	SSKG-250- -4T	NA	¼-inch
17	Hand Valve	Robbins Aviation	SSKG-250- -4T	NA	¼-inch
18	Thermocouple	Honeywell Corp.	30112	NA	-50 to +200°F ±2.5% (temperature test only)
19	Thermal Chamber	Conrad Corporation	NA	NASA 08-113-2049 -41	-25 to +165°F (temperature test only)
20	Leakage Detector	Pyrex Co.	NA	NA	400 ml. capacity (leakage test) graduated cylinder and beaker
21	Valve-Stem Adapter	CCSD	NA	NA	Replace hand wheel of specimen (when required)
22	Torque Wrench	Armstrong	SR-100	NASA 95-1318B	

Table 4-2. Functional Test Data

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (in-lb)	Running Torque (in-lb)		Closing Torque (in-lb)
				Opening	Closing	
1	100	6000	60	110	130	120
	100	0	80	.5	1.5	—
		2	—	—	—	50
2	120	6000	70	110	140	120
	100	0	80	.5	1.5	—
		2	—	—	—	25
3	120	6000	60	100	140	140
	100	0	130	1.0	1.2	—
		2	—	—	—	20
4	140	6000	80	115	140	140
	100	0	140	1.0	1.2	—
		2	—	—	—	40
5	140	6000	70	110	140	140
	100	0	140	1.2	1.2	—
		2	—	—	—	40
6	140	6000	50	90	140	140
	100	0	145	1.0	1.0	—
		2	—	—	—	45
7	140	6000	60	85	135	140
	100	0	145	1.0	1.0	—
		2	—	—	—	60
8	140	6000	60	85	140	145
	100	0	145	1.0	1.0	—
		2	—	—	—	40
9	145	6000	80	100	140	150
	130	0	150	1.0	1.0	—
		2	—	—	—	50
10	150	6000	90	105	140	145
	140	0	155	1.0	1.0	—
		2	—	—	—	45

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	None
	100	0	6000	None
2	100	6000	0	None
	100	0	6000	None



Note: All lines ¼-inch.
Refer to table 4-1 for item identification.

Figure 4-1. Functional Test Schematic

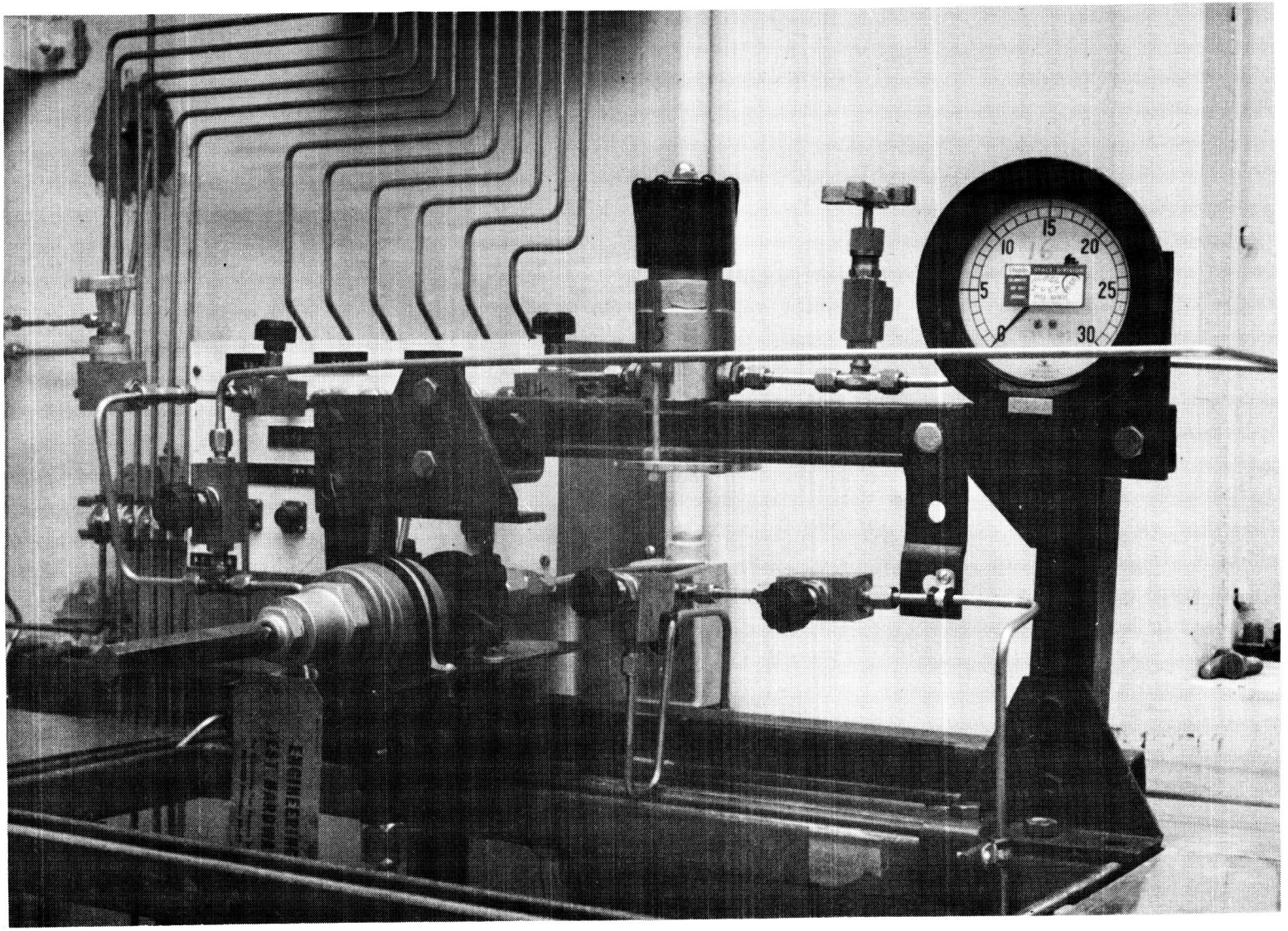


Figure 4-2. Functional Test Setup

SECTION V

FLOW TEST

5.1 TEST REQUIREMENTS

5.1.1 The valve capacity (C_v) of the specimen shall be determined. The minimum C_v shall be 1.1.

5.2 TEST PROCEDURE

5.2.1 The test specimen was installed in the test setup as shown in figures 5-1 and 5-3 using the equipment listed in table 5-1. All hand valves and regulators were closed.

5.2.2 The test specimen was opened.

5.2.3 Hand valve 3 was opened and gage 4 was monitored for 100 psig.

5.2.4 Regulator 5 was used to adjust the flow rate to the specimen over the full range of the testing.

5.2.5 Ten readings were recorded in gallons per minute. Specimen inlet pressure and pressure drop indicated by gages 9, 10, and 11 and the water temperature as indicated by thermocouple 8 were recorded.

5.3 TEST RESULTS

The flow coefficient (C_v) of the specimen was an average of 1:1 when calculated over a flow range between 2 to 9 gallons per minute.

5.4 TEST DATA

5.4.1 Test data recorded during the test are presented in table 5-2. Pressure drop versus flow rate is presented in figure 5-3.

5.4.2 The flow coefficient (C_v) was computed using the following formula:

$$C_v = Q\sqrt{\frac{\rho_T}{\rho_{\Delta P}}}$$

Where: Q = Measured flow rate (gpm)
ΔP = Pressure drop across the specimen (psid)
T = Density of the water at the temperature indicated by the temperature probe
ρ = Density of the water at 60°F

5.4.3 Data from the pre-flow functional test are presented in table 5-3.

Table 5-1. Flow Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Combination Pump and Valve Co.	371	NA	½-inch angle valve
2	Water Supply	NA	NA	NA	Tap water
3	Hand Valve	Williams Co.	200SP	NA	2-inch
4	Pressure Gage	Heise	NA	NASA 08-113-93-1092-C	0-to 1000-psig ±0.2% FS Cal dates 9-21-66 12-30-66 3-21-67
5	Pressure Regulator	Denison Division, American Brake Shoe Company	FCC122-3106	NA	1-inch
6	Pressure Gage	Ashcroft	NA	NASA 08-113-95-1209-B	0-to 1000-psig ±1.0% FS Cal dates 10-30-66 1-30-67 4-30-67
7	Turbine Flow-Meter	Cox Instrument Division	16-SCRX	3498	0-to 50-gpm Cal dates 9-18-66 12-16-66 3-13-67
8	Thermocouple	West Instrument Corporation	30112	NA	-50 to +200°F ±2.5°F Cal dates 10-3-66 2-31-67
9	Pressure Gage	Heise	NA	NASA 08-113-95-1637-B	0-to 100-psig ±0.2% FS Cal dates 9-21-66 12-30-66 3-21-67

Table 5-1. Flow Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
10	Pressure Gage	Heise	NA	NASA 08-113-95-1083-C	0-to 100-psig ±0.2% FS Cal dates 9-21-66 12-30-66 3-21-67
11	Pressure Gage	Heise	NA	NASA 08-113-93-1064-C	0-to 100-psig ±0.2% FS Cal dates 9-21-66 12-30-66 3-21-67
12	Hand Valve	Williams Co.	200SP	NA	2-inch

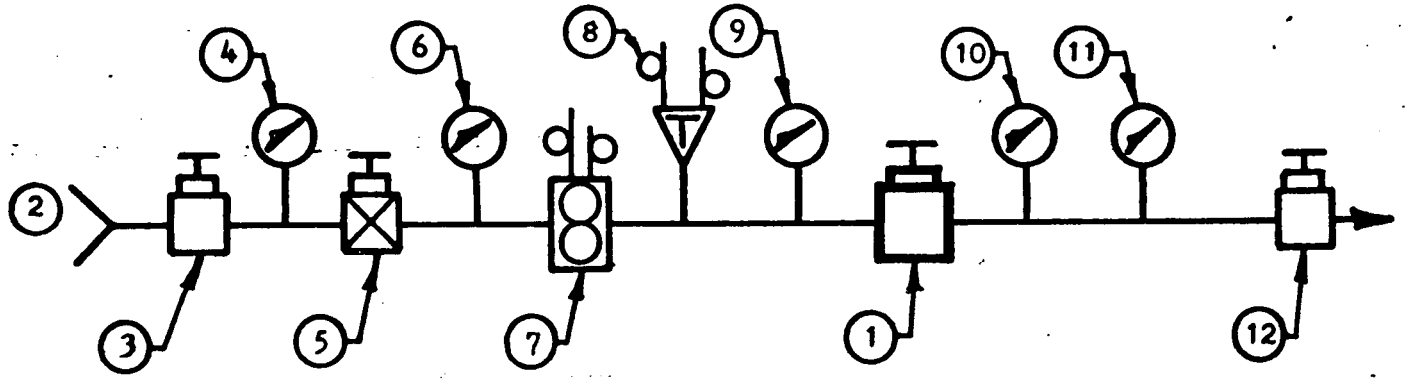
Table 5-2. Flow Test Data

Flow (gpm)	Specimen Pressure (psig)		Tare (psi)	△P (psi)	Media Temperature (°F)
	Upstream	Downstream			
2	4.5	1.2	0.8	2.5	46
3	8.8	1.4	0.9	6.5	46
4	14.3	1.6	1.4	11.3	46
5	22.1	1.8	1.3	19.0	46
6	36.0	2.5	1.8	31.7	46
8	76.5	3.9	2.3	70.3	46
8.8	97.0	4.9	2.6	89.5	46
8	77.3	4.5	2.3	70.5	46
6	35.0	2.8	1.5	30.7	46
5	22.3	2.1	1.1	19.1	46
4	14.3	1.6	0.9	11.8	46
3	8.7	1.2	0.7	6.8	46
2	4.5	1.2	0.7	2.6	46

Table 5-3. Pre-Flow Functional Test Data

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (in-lb)	Running Torque (in-lb)		Closing Torque (in-lb)
				Opening	Closing	
1	100	6000	70	110	160	160
	100	0	180	1.0	1.0	—
	100	2	—	—	—	40
2	100	6000	85	95	150	160
	100	0	180	1.0	1.0	—
	100	2	—	—	—	35
3	100	6000	60	100	155	150
	100	0	170	1.0	1.0	—
	100	2	—	—	—	40

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	None
	100	0	6000	None
2	100	6000	0	None
	100	0	6000	None



Note: All lines 3/4-inch.
Refer to table 5-1 for item identification.

Figure 5-1. Flow Test Schematic

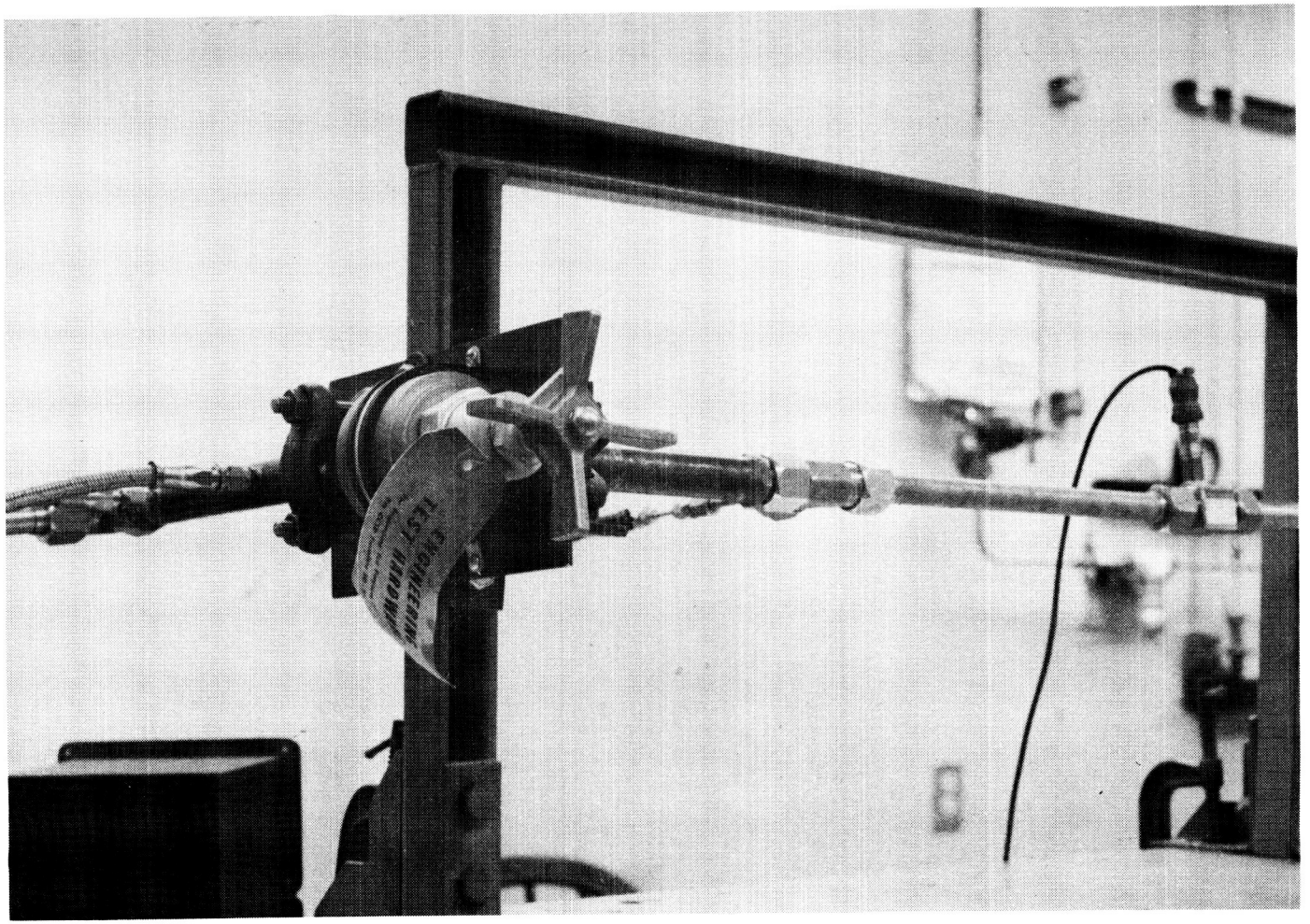


Figure 5-2. Flow Test Setup

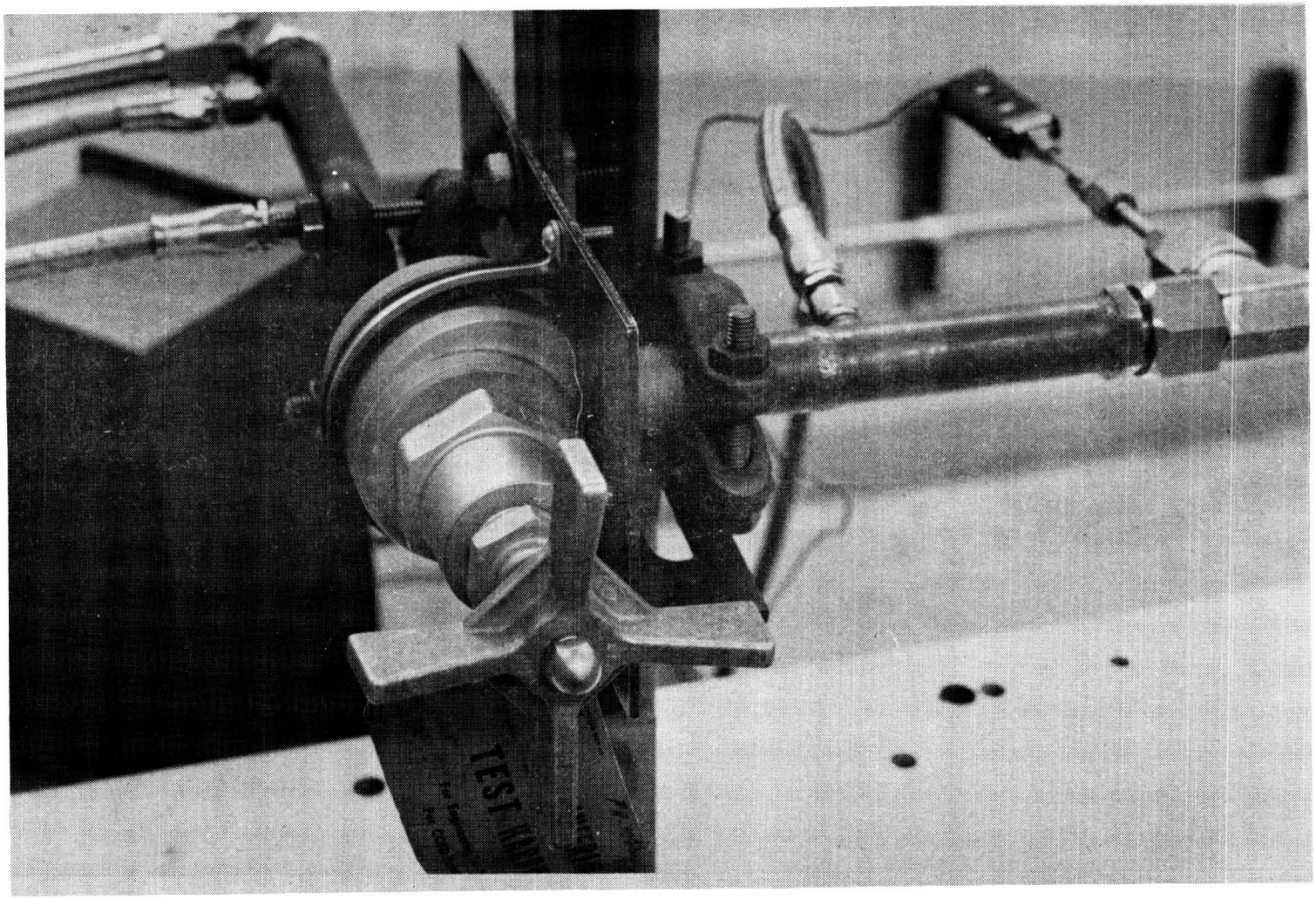


Figure 5-3. Flow Test Close-up

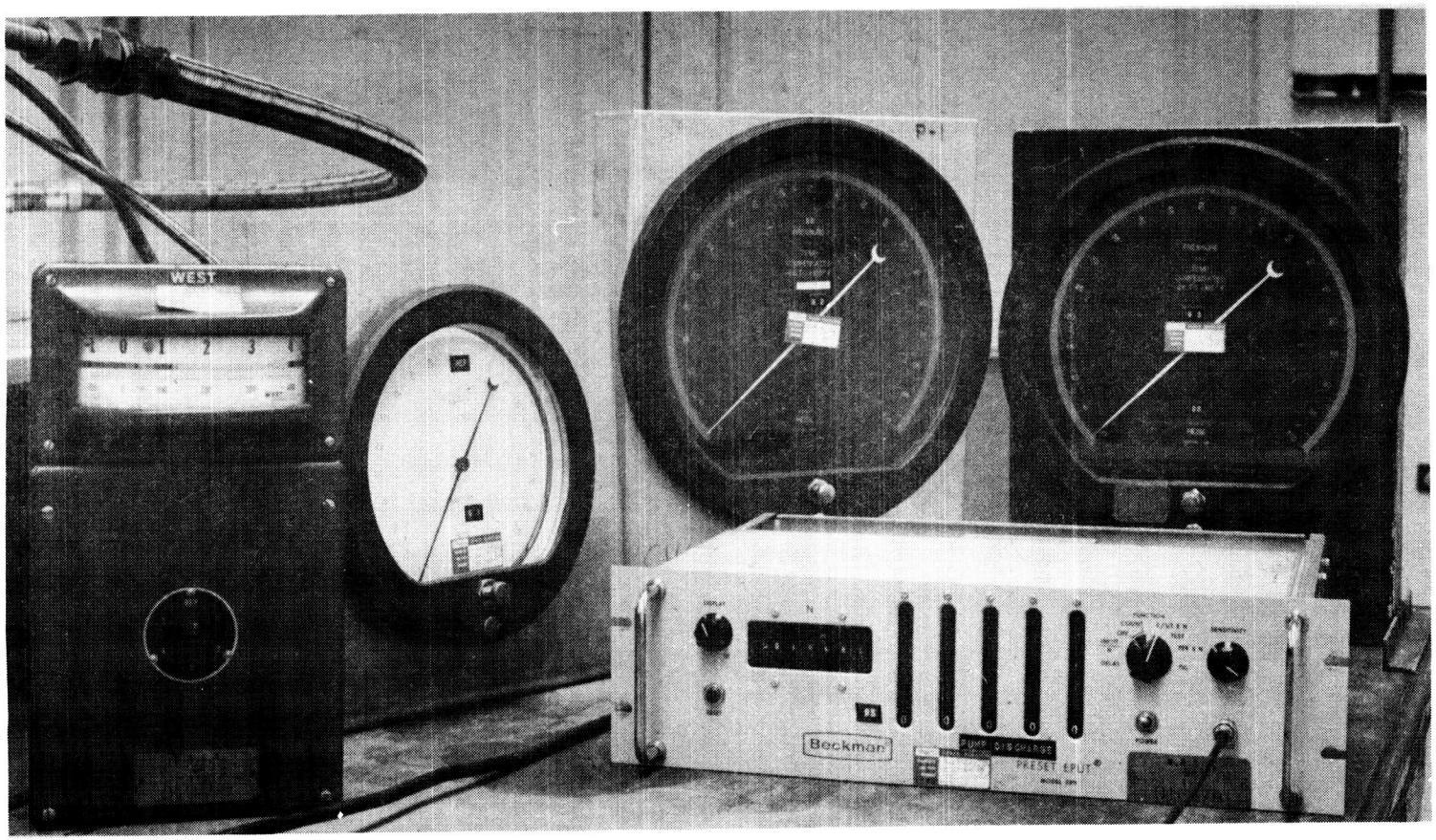


Figure 5-4. Flow Test Instrumentation

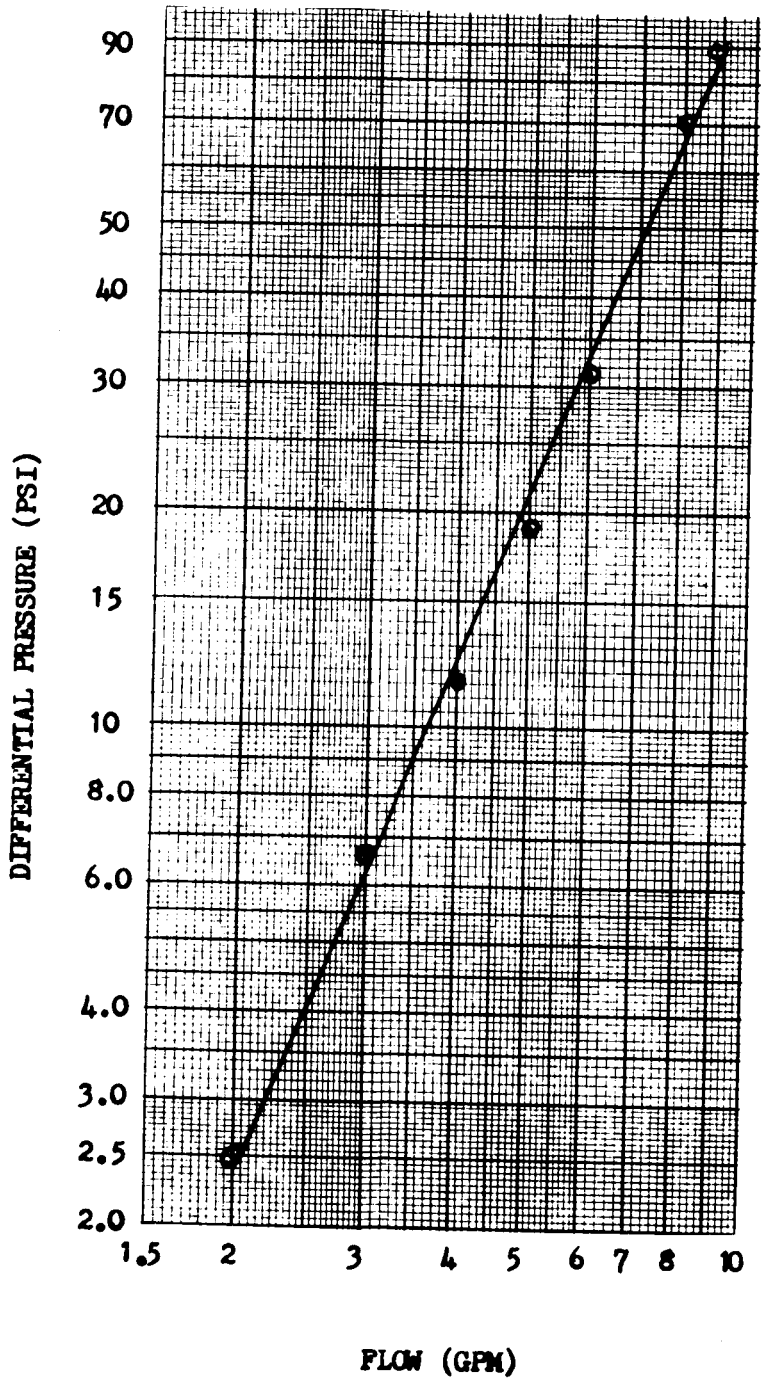


Figure 5-5. Flow Rate Versus Pressure

SECTION VI

SURGE TEST

6.1 TEST REQUIREMENTS

6.1.1 The test specimen shall be subjected to 20 pressure surges, 10 with the specimen closed and 10 with the specimen partially opened.

6.1.2 Each pressure surge shall be a pressure increase from zero to 6000 psig within 100 milliseconds.

6.1.3 The downstream side of the specimen shall be vented after each surge, when specimen is partially opened.

6.2 TEST PROCEDURE

6.2.1 The test specimen was installed in the test setup as shown in figures 6-1 and 6-2 using the equipment listed in table 6-1. All hand valves, regulators and the specimen were closed for zero pressure.

6.2.2 Hand valve 2 was opened.

6.2.3 Pressure gage 4 indicated the supply pressure of 7000 psig.

6.2.4 Regulator 5 was adjusted until gage 6 indicated 6000 psig.

6.2.5 Switch 18 was closed, solenoid valve 8 actuated and the inlet port of the specimen was pressurized to 6000 psig.

6.2.6 The output from pressure transducer 15 and the time for each run were recorded on oscillograph 16.

6.2.7 Switch 18 was opened and solenoid valve 8 deactuated.

6.2.8 Procedures 6.2.5 through 6.2.7 were repeated 10 times.

6.2.9 The specimen was partially opened (cracked), and the vent port of solenoid valve 8 was capped.

6.2.10 Procedures 6.2.5 through 6.2.7 were repeated for 10 additional cycles, hand valve 12 was opened after each cycle, and the downstream pressure was vented from the specimen.

6.2.11 The specimen was examined for distortion after each cycle, and was functionally tested prior to and after surge testing. The data were recorded.

6.3 TEST RESULTS

The specimen was cycled 10 times in the closed position with a pressure of zero to 6000 psig at a rise rate of 30 milliseconds. The second 10 cycles were performed with the specimen in the

partially opened (cracked) position. No damage was in evidence.

6.4 TEST DATA

6.4.1 A typical surge waveform, recorded during the test, is shown in figure 6-4.

6.4.2 Data recorded during the pre-surge and post-surge functional tests are presented in tables 6-2 and 6-3.

Table 6-1. Surge and Cycle Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Combination Pump and Valve Co.	371	NA	½-inch angle valve
2	Hand Valve	Combination Pump and Valve Co.	380-3	NA	1½-inch supply
3	Filter	Microporous	4813F-2M	NA	2-micron
4	Pressure Gage	Ashcroft	NA	NASA 08-113-200594-P	0-to 10,000-psig ±0.2% FS Cal dates 12-8-66 3-7-67
5	Pressure Regulator	Tescom Corp.	26-1002	1004	7000-psig inlet 0-to 7000-psig outlet
6	Pressure Gage	Ashcroft	NA	NASA 08-113-200594-Q	0-to 10,000-psig ±0.2% FS Cal dates 12-8-66 3-7-67
7	Hand Valve	Robbins Aviation	SSKG-250-4T	NA	¼-inch
8	Solenoid Valve	Marotta Valve Co.	MV-583	3696	3-way, ½-inch
9	Hand Valve	Robbins Aviation	SSKG-250-4T	NA	¼-inch
10	Pressure Gage	Ashcroft	NA	NASA 08-113-200594-B	0-to 10,000-psig ±0.2% FS Cal dates 12-8-66 3-7-67
11	Helium and Nitrogen Source	CCSD	NA	NA	7000-psig
12	Hand Valve	Robbins Aviation	SSKG-250-4T	NA	¼-inch
13	Solenoid Valve	Marotta Valve Co.	MV-583	2916	3-way, ½-inch

Table 6-1. Surge and Cycle Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
14	Reduction Motor and Gear	Westinghouse	NA	NA	Refer to electrical schematic for identification
15	Pressure Transducer	Teledyne	176	652137	0-to 7500-psig ±0.2% FS
16	Oscillograph Recorder	C. E. C.	5-124	NASA 017887	
17	Electrical Supply	Plant Services	NA	NA	28-vdc and 115-vac
18	Switch				

Table 6-1A. Surge and Cycle Electrical Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
	Motor, Elec.	Westinghouse	Life-Line CSP	NA	3-hp, 440-vac, 3-phase
	Gear Drive	Boston Gear Co.	U-145-50	NA	1750-rpm input 35-rpm output
	Cycle Timer	Cramer Controls	523	Y2389A	115-vac, 28-vdc
	Limit Switch	Honeywell	Micro-Switch	NA	28-vdc
	Relay, Time Delay	ESNA	ND-12QT	J57910	
	Relay, Time Delay	ESNA	ND-12QT	J57909	
	Counter	General Controls	Mercury	NA	5-digits
	Switches	Underwriters Laboratory, Inc.	NA	NA	5-amp., 115-vac 20-amp., 230-vac
	Relays	Magnetic Elec. Co.	NA	NA	115-vac, 5-amp. 400-ohm cuit.

Table 6–2. Pre–Surge Functional Test Data

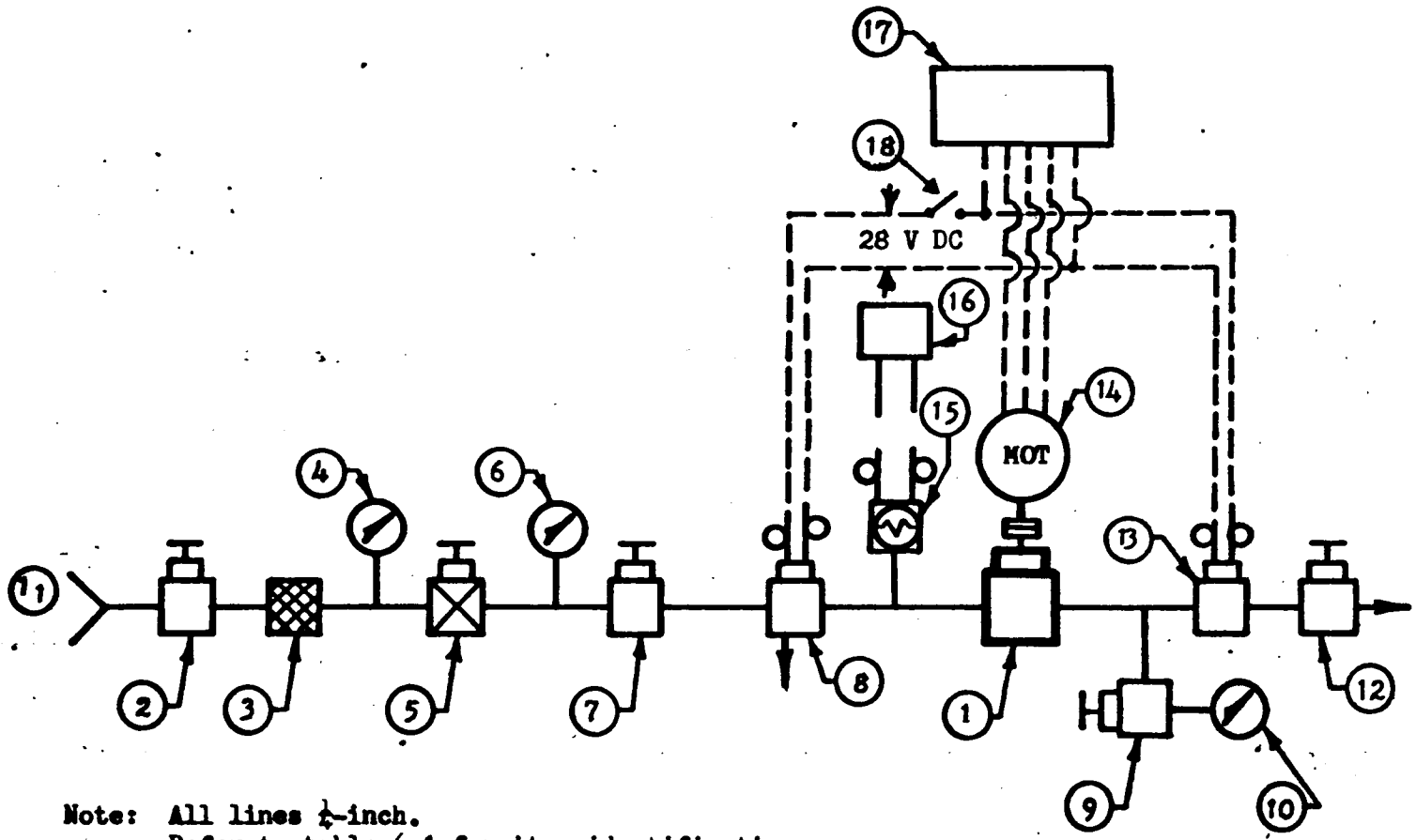
Run	Applied Seating Torque (in–lb)	Specimen Inlet Pressure (psig)	Opening Torque (in–lb)	Running Torque (in–lb)		Closing Torque (in–lb)
				Opening	Closing	
1	100	6000	110	130	160	120
	100	0	145	1.0	1.0	—
	100	2	—	—	—	25
2	100	6000	80	95	140	120
	100	0	120	1.5	1.0	—
	100	2	—	—	—	25
3	100	6000	90	95	145	140
	100	0	140	1.0	1.0	—
	100	2	—	—	—	35

Run	Applied Seating Torque (in–lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	None
	140	0	6000	None

Table 6-3. Post-Surge Functional Test Data

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (in-lb)	Running Torque (in-lb)		Closing Torque (in-lb)
				Opening	Closing	
1	100	6000	130	100	150	150
	100	0	55	1.0	1.0	—
	100	2	—	—	—	35
2	100	6000	110	90	130	150
	100	0	75	1.0	1.0	—
	100	2	—	—	—	40
3	100	6000	85	90	125	150
	100	0	70	1.0	1.0	—
	100	2	—	—	—	50

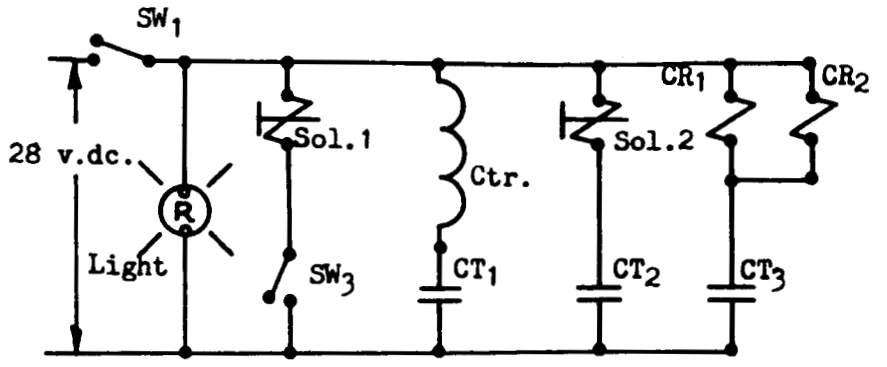
Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	None
	150	0	6000	None



Note: All lines ¼-inch.
Refer to table 6-1 for item identification.

Figure 6-1. Surge And Cycle Test Schematic

Note: Refer to table 6-1A for item identification.



NOTE: CR_1-Set time to allow delay in open position and time to close valve. ($CR_1 > CR_2$)
CR_2-Set time delay for length of time necessary to open test specimen.
CT_1-Set cam to actuate once per cycle in any position.
CT_2-Cam actuates to vent during interval when test specimen is closed.
CT_3-Cam set so that SW_3 is actuated in the total time interval for opening, delay in the open position and closing of the valve.

Sol.1-Inlet pressure solenoid,3-way
Sol.2-Vent Solenoid, 3-way

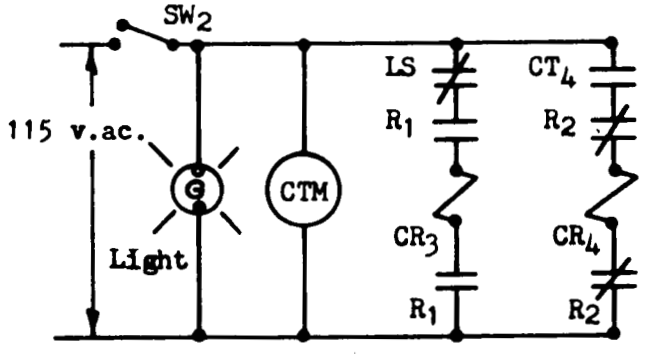
Light-Ind.light-RED

Ctr-28v.dc.counter

CT_1;CT_2;CT_3-Tips of cycle timer-N.O.

CR_1;CR_2-Time delay relay - TOE

SW_1;SW_3-28V.dc.- ON-OFF switch.



NOTE: CT_4- Setting same as CT_3.

CTM-Cycle timer motor

CT_4-Tips of cycle timer - N.O.

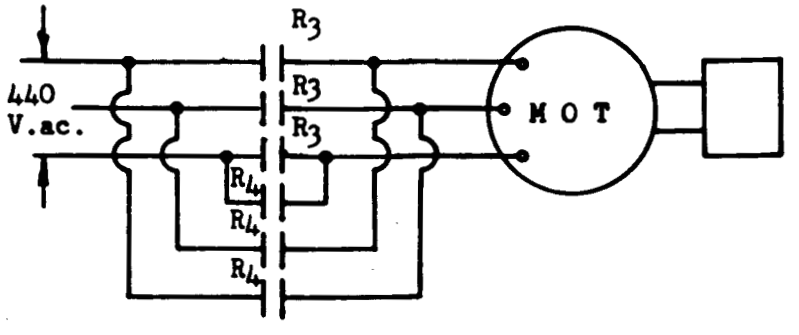
LS-Stroke travel limit switch - N.C.

R_1-Tips of CR_1 - N.O.
R_2-Tips of CR_2- N.C.

Light-Ind.light-GREEN

CR_3;CR_4-Coils of reverse contacts

SW_2-115 v.ac.- ON-Off switch.



R_3- Tips of CR_3- N.O.
R_4- Tips of CR_4- N.O.

MOT-3 hp., 440 v., 3 phase, motor.

Figure 6-1A. Cycle Electrical Test Schematic

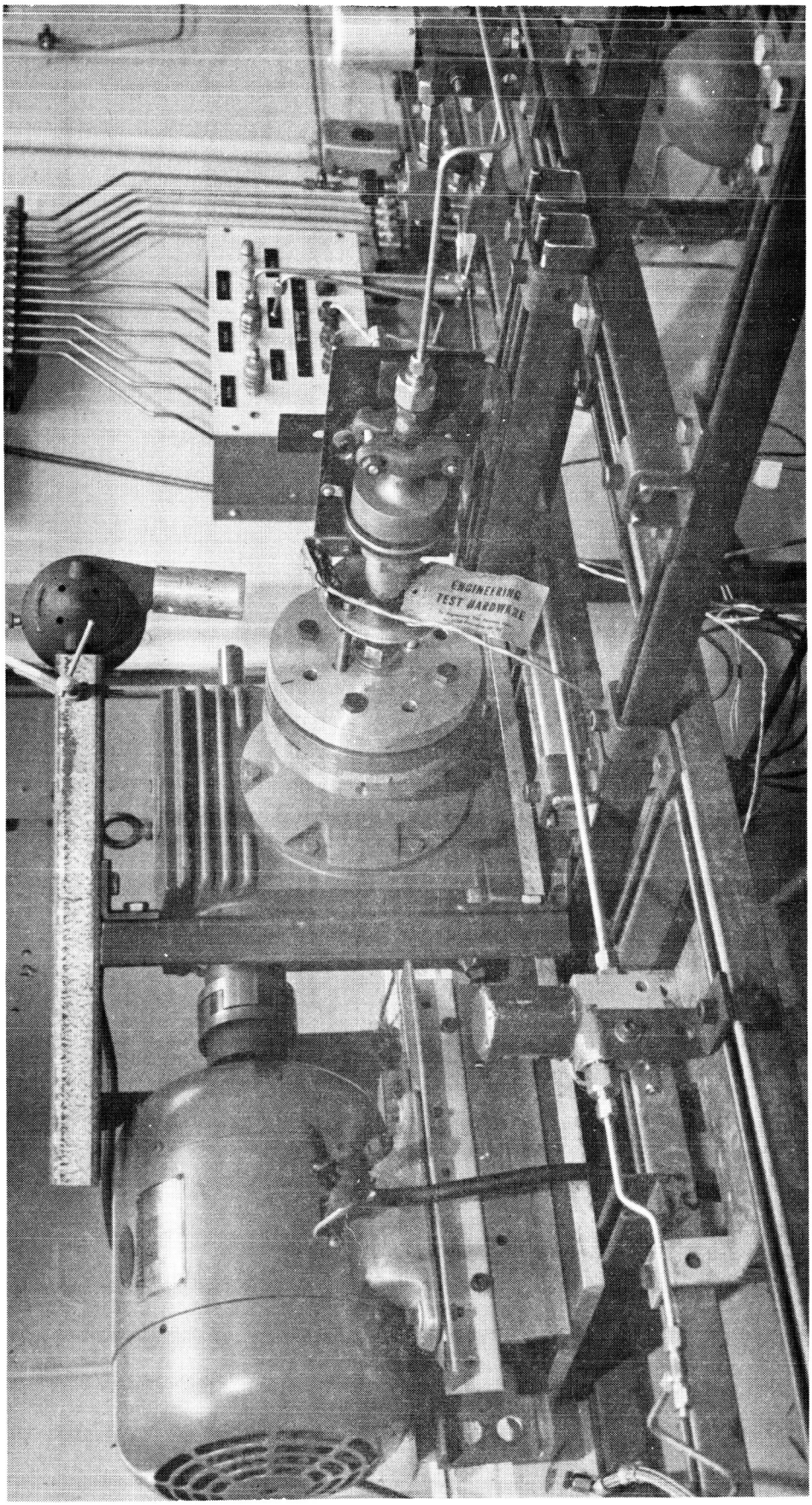


Figure 6-2. Surge And Cycle Test Setup

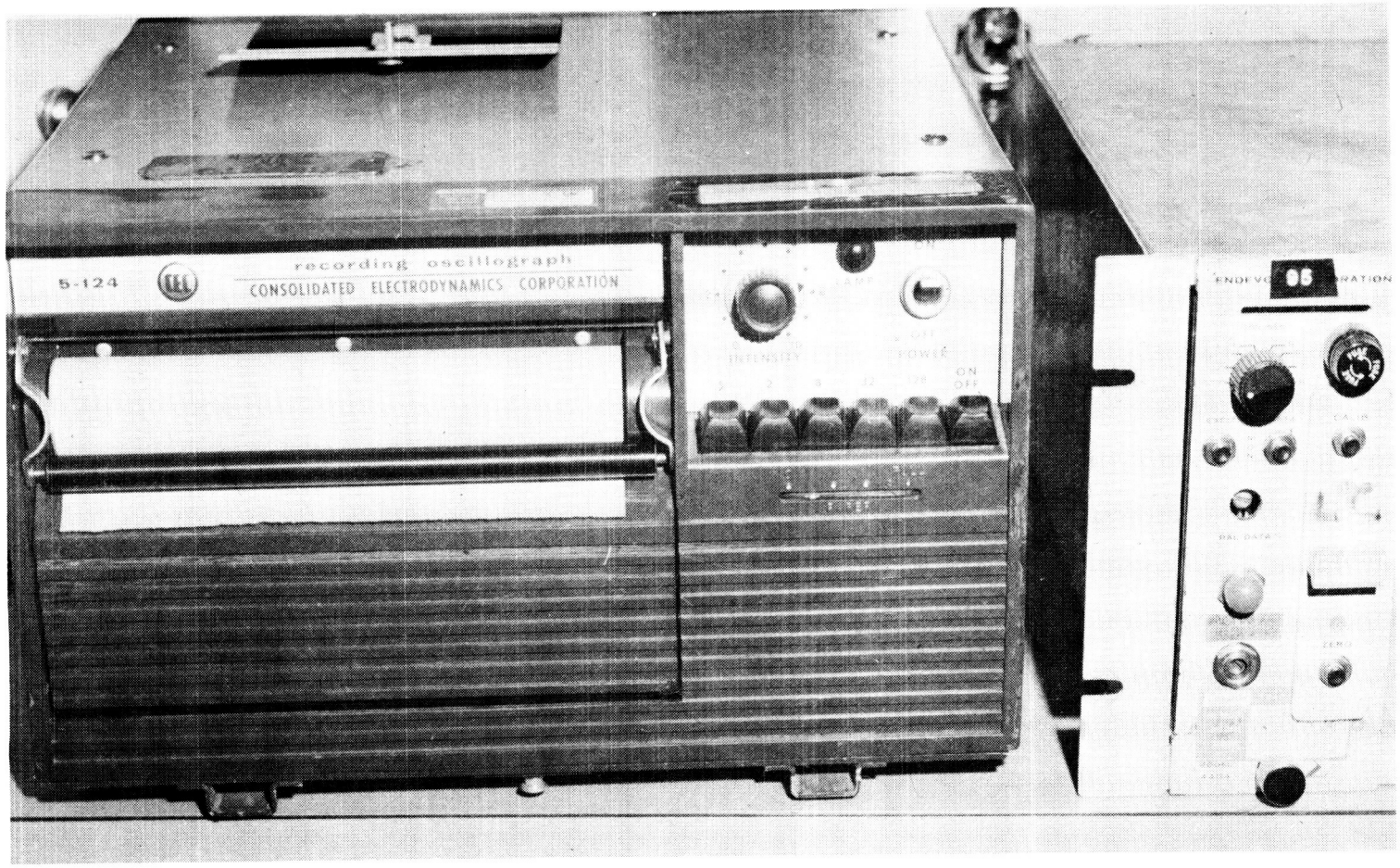


Figure 6-3. Surge And Cycle Tests Instrumentation

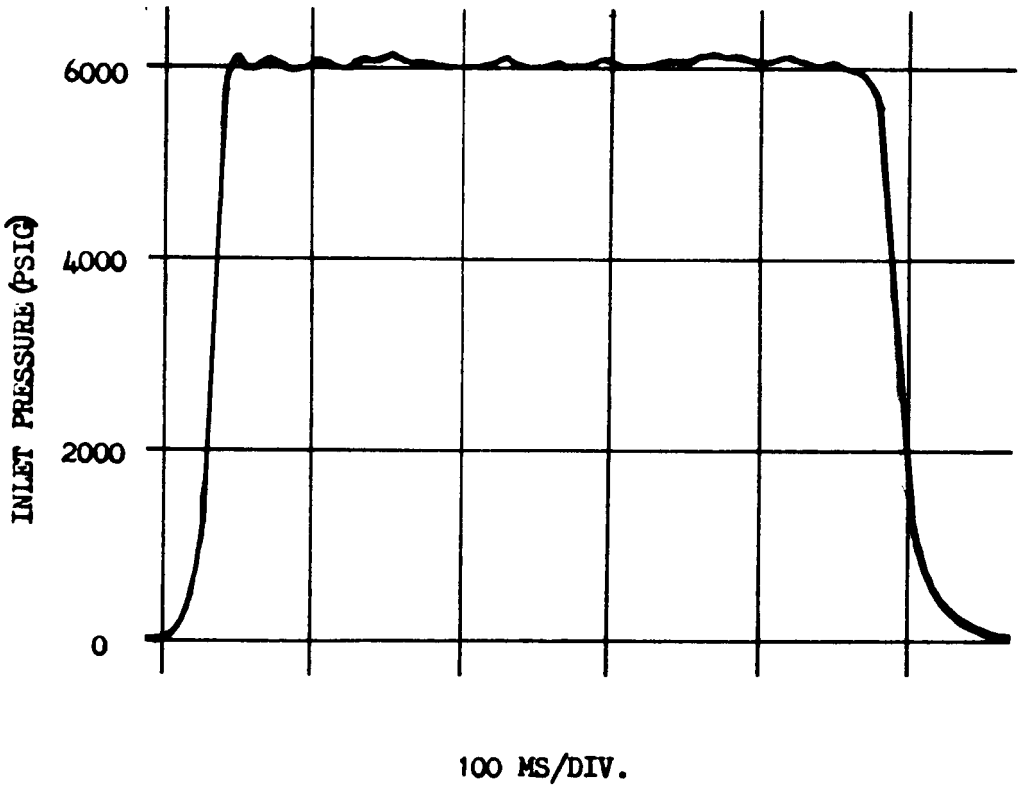


Figure 6-4. Typical Surge Waveform

SECTION VII

LOW TEMPERATURE TEST

7.1 TEST REQUIREMENTS

7.1.1 The test specimen shall be subjected to a low temperature test at +5 (+0, -4)°F to determine whether the environment causes degradation or deformation.

7.1.2 The test specimen shall be subjected to a functional test in accordance with section IV during the low temperature test using helium as the test medium.

7.2 TEST PROCEDURE

7.2.1 The specimen was installed in the test setup as shown in figures 7-1 and 7-3 using the equipment listed in table 4-1.

7.2.2 Thermocouple 19 was affixed to the specimen, thermal chamber 18 was cooled to +5°F, and the relative humidity was maintained between 60 to 90 per cent.

7.2.3 Temperature stabilization was achieved and a functional test was performed.

7.2.4 The chamber was returned to ambient temperature and a second functional test was performed.

7.2.5 The specimen was visually inspected within one hour of its return to ambient temperature.

7.3 TEST RESULTS

The specimen demonstrated no apparent adverse effects from thermal changes except for a slight increase in the seating torque at +5°F. The torque returned to normal at ambient.

7.4 TEST DATA

Data recorded during the test are presented in tables 7-1, 7-2, and 7-3.

Table 7-1. Pre-Low Temperature Functional Test Data

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (in-lb)	Running Torque (in-lb)		Closing Torque (in-lb)
				Opening	Closing	
1	100	6000	130	100	150	150
	100	0	50	1.0	1.0	---
	100	2	---	---	---	30
2	100	6000	100	85	125	150
	100	0	75	1.0	1.0	---
	100	2	---	---	---	45
3	100	6000	85	80	120	130
	100	0	65	1.0	1.0	---
	100	2	---	---	---	50

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	None
	150	0	6000	None

Table 7-2. Low Temperature Functional Test Data at +5°F

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (in-lb)	Running Torque (in-lb)		Closing Torque (in-lb)
				Opening	Closing	
1	100	6000	125	135	150	95
	100	0	75	1.0	2.0	—
	100	2	—	—	—	45
2	100	6000	125	130	140	160
	100	0	60	2.0	3.0	—
	100	2	—	—	—	85
3	100	6000	130	135	145	160
	100	0	60	2.0	3.0	—
	100	2	—	—	—	75

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	None
	250	0	6000	None

Table 7-3. Post-Low Temperature Functional Test Data

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (in-lb)	Running Torque (in-lb)		Closing Torque (in-lb)
				Opening	Closing	
1	100	6000	75	80	110	125
	100	0	60	0.5	1.0	—
	100	2	—	—	—	65
2	100	6000	65	75	105	130
	100	0	50	0.5	1.0	—
	100	2	—	—	—	70
3	100	6000	70	75	105	130
	100	0	55	0.5	1.0	—
	100	2	—	—	—	70

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	None
	150	0	6000	None

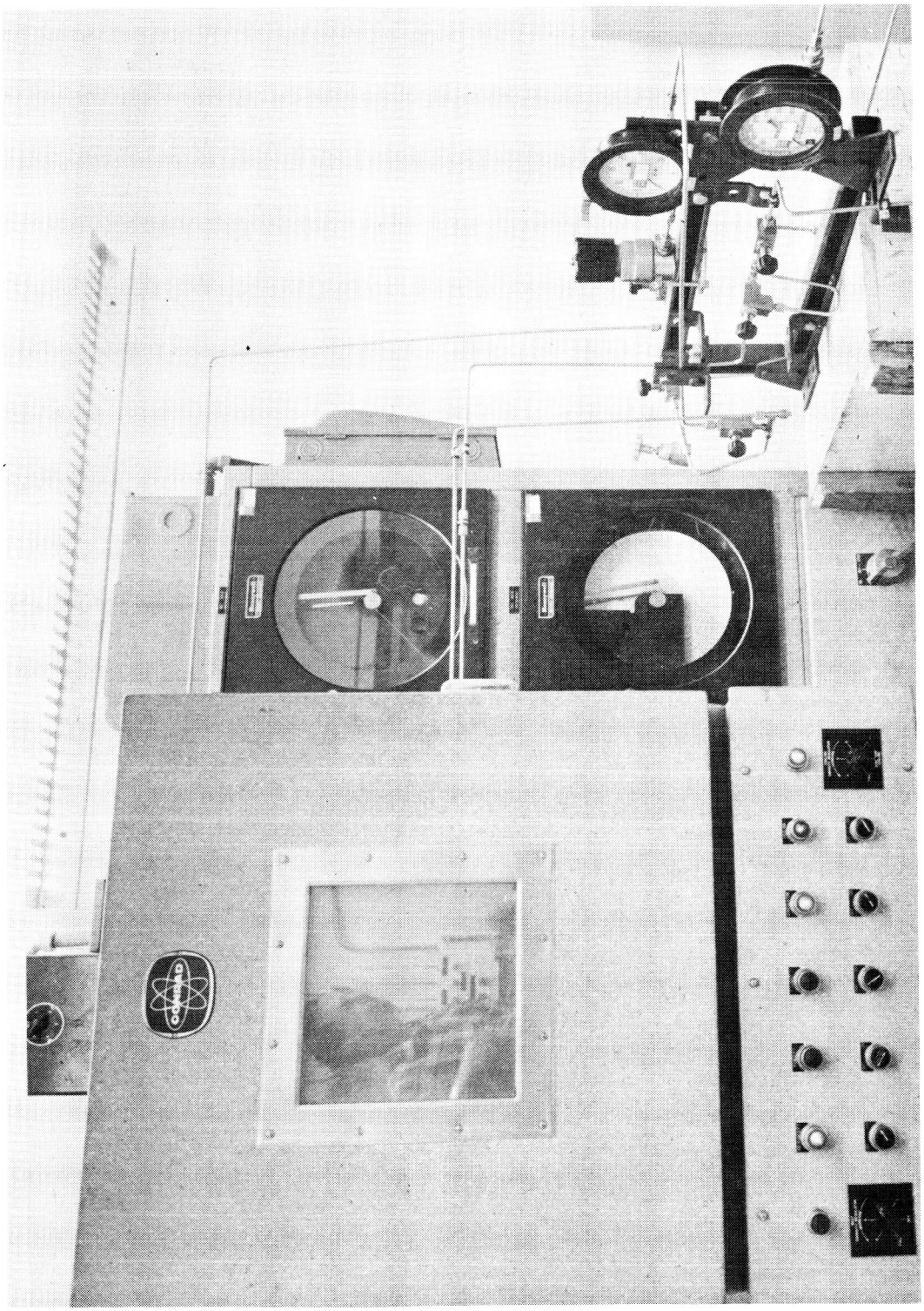


Figure 7-1. Low And High Temperature Tests Console

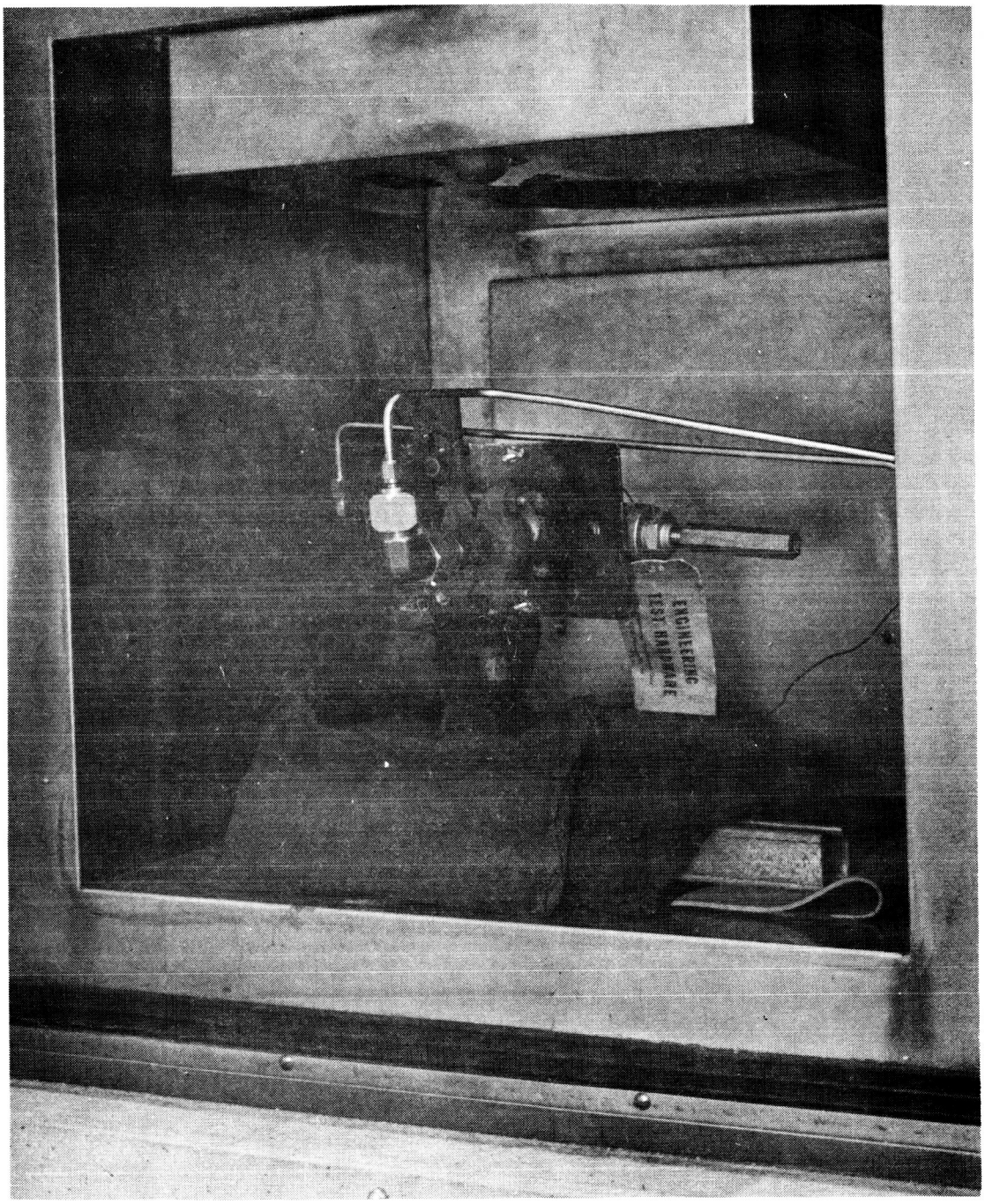


Figure 7-2. Low And High Temperature Tests Close-up

SECTION VIII

HIGH TEMPERATURE TEST

8.1 TEST REQUIREMENTS

8.1.1 The test specimen shall be subjected to a high temperature test at 160 (+4, -0)°F for a period of 72 (+2, -0) hours to determine if the environment causes degradation of performance.

8.1.2 The test specimen shall be subjected to a functional test in accordance with section IV during and after the high temperature test using helium as the test medium.

8.2 TEST PROCEDURE

8.2.1 The specimen was installed in the test setup as shown in figures 7-1 and 7-3 using the equipment listed in table 4-1.

8.2.2 Thermocouple 19 was affixed to the specimen, and temperature of thermal chamber 18 was increased to 160°F at a rise rate of approximately 1° per minute. The humidity was maintained at 20 per cent.

8.2.3 The 160°F temperature was maintained for 72 hours after temperature stabilization.

8.2.4 A functional test was performed while the specimen and chamber were at 160°F.

8.2.5 The chamber temperature was returned to ambient conditions upon completion of the functional test.

8.2.6 Within one hour following the establishment of ambient conditions, a visual inspection and functional test were performed on the specimen.

8.3 TEST RESULTS

The test specimen demonstrated no adverse effects from the thermal change.

8.4 TEST DATA

Data recorded during the test are presented in tables 8-1 and 8-2.

Table 8-1. Functional Test Data At +160°F

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (in-lb)	Running Torque (in-lb)		Closing Torque (in-lb)
				Opening	Closing	
1	100	6000	65	70	110	125
	100	0	70	1.0	1.0	—
	100	2	—	—	—	75
2	100	6000	70	75	110	150
	100	0	75	1.0	1.0	—
	100	2	—	—	—	65
3	100	6000	75	80	110	120
	100	0	60	1.0	1.0	—
	100	2	—	—	—	55

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
	100	6000	0	None
	150	0	6000	None

Table 8-2. Post-High Temperature Functional Test Data At Ambient

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (in-lb)	Running Torque (in-lb)		Closing Torque (in-lb)
				Opening	Closing	
1	100	6000	75	80	115	120
	100	0	65	0.5	1.0	—
	100	2	—	—	—	15
2	100	6000	80	80	120	120
	100	0	60	0.5	1.0	—
	100	2	—	—	—	70
3	100	6000	75	80	120	115
	100	0	60	0.5	1.0	—
	100	2	—	—	—	65

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	None
	150	0	6000	None

SECTION IX

CYCLE TEST

9.1 TEST REQUIREMENTS

9.1.1 The test specimen shall be subjected to 1000 cycles.

9.1.2 Each cycle shall consist of pressurizing the inlet port to 6000 psig and then opening and closing the specimen. GN_2 shall be the test medium.

9.1.3 The specimen downstream pressure shall be vented to below 3100 psig after each cycle.

9.1.4 A functional test, as specified in section IV, shall be performed following the completion of 50, 100, 500 and 1000 cycles.

9.2 TEST PROCEDURE

9.2.1 The specimen was installed in the test setup as shown in figures 6-1 and 6-2 using the equipment listed in table 6-1.

9.2.2 All hand valves and regulators were adjusted for zero pressure.

9.2.3 Hand valve 2 was opened and gage 4 indicated 7000 psig.

9.2.4 Regulator 5 was adjusted until 6000 psig was indicated on gage 6.

9.2.5 The electrical network was adjusted and the following events were sequenced:

a. Solenoid valve 9 actuated and the specimen was pressurized to 6000 psig, as indicated on gage 6.

b. Solenoid valve 13 actuated and the outlet port was closed during specimen opening and closing.

c. Reversible electrical motor 14 opened and closed the specimen.

d. Solenoid valves 8 and 13 deactuated and vented the downstream pressure from the specimen to below 3000 psig as indicated on gage 10.

9.2.6 Functional tests were performed after 50, 100, 500 and 1000 cycles of the specimen.

9.3 TEST RESULTS

No malfunction or degradation occurred other than an increase in the seating and closing torques, after 500 cycles, to a range of 180 inch-pounds as compared to a typical 150 inch-pounds range observed earlier in the test.

9.4 TEST DATA

Data recorded during the test are presented in tables 9-1 through 9-5.

Table 9-1. Pre-Cycle Functional Test Data

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (in-lb)	Running Torque (in-lb)		Closing Torque (in-lb)
				Opening	Closing	
1	100	6000	60	60	95	95
	100	0	50	1.0	1.0	—
	100	2	—	—	—	60
2	100	6000	60	60	85	110
	100	0	50	1.0	1.0	—
	100	2	—	—	—	60
3	100	6000	60	60	95	95
	100	0	50	1.0	1.0	—
	100	2	—	—	—	60

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	None
	145	0	6000	None

Table 9-2. Functional Test Data After 50 Cycles

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (in-lb)	Running Torque (in-lb)		Closing Torque (in-lb)
				Opening	Closing	
1	100	6000	60	60	85	95
	100	0	50	1.0	1.0	—
	100	2	—	—	—	60
2	100	6000	60	60	85	95
	100	0	50	1.0	1.0	—
	100	2	—	—	—	60
3	100	6000	60	60	95	95
	100	0	50	1.0	1.0	—
	100	2	—	—	—	60

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
	100	6000	0	None
	145	0	6000	None

Table 9-3. Functional Test Data After 100 Cycles

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (in-lb)	Running Torque (in-lb)		Closing Torque (in-lb)
				Opening	Closing	
1	100	6000	60	50	70	95
	100	0	70	1.0	1.0	---
	100	2	---	---	---	70
2	100	6000	60	35	70	95
	100	0	70	1.0	1.0	---
	100	2	---	---	---	70
3	100	6000	60	50	70	95
	100	0	70	1.0	1.0	---
	100	2	---	---	---	60

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	None
	145	0	6000	None

After 159 cycles, direction of flow was changed.

Table 9-4. Functional Test Data After 500 Cycles

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (in-lb)	Running Torque (in-lb)		Closing Torque (in-lb)
				Opening	Closing	
1	180	6000	120	50	70	180
	180	0	155	1.0	1.0	---
	180	2	---	---	---	85
2	180	6000	132	50	85	180
	180	0	85	1.0	1.0	---
	180	2	---	---	---	85
3	180	6000	120	50	70	180
	180	0	95	1.0	1.0	---
	180	2	---	---	---	85

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	180	6000	0	None
	95	0	6000	None

Table 9-5. Functional Test Data After 1000 Cycles

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (in-lb)	Running Torque (in-lb)		Closing Torque (in-lb)
				Opening	Closing	
1	180	6000	120	50	70	180
	180	0	155	1.0	1.0	---
	180	2	---	---	---	145
2	180	6000	120	35	85	180
	180	0	120	1.0	1.0	---
	180	2	---	---	---	120
3	180	6000	120	35	85	180
	180	0	120	1.0	1.0	---
	180	2	---	---	---	120

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	180	6000	0	None
	95	0	6000	None

SECTION X

BURST TEST

10.1 TEST REQUIREMENTS

10.1.1 The specimen shall be subjected to a hydrostatic pressure of 24,000 psig.

10.1.2 The hydrostatic pressure shall be applied simultaneously to the specimen inlet and outlet ports with the valve in the open position. The pressure shall be maintained for 5 minutes.

10.2 TEST PROCEDURE

10.2.1 The test specimen was installed in the test setup as shown in figures 3-1 and 3-3 using the equipment listed in table 3-1.

10.2.2 Regulator 15 was adjusted for zero outlet pressure. The specimen and hand valves 5, 6, 8, 9, 10, 11 and 24 were opened and the system was filled with de-ionized water. All air was bled from the system.

10.2.4 Hand valves 5, 8, 9, 11 and 24 were closed.

10.2.5 Hand valve 7 was opened, and 3000 psig GN_2 pressure was indicated on gage 14.

10.2.6 Regulator 21 was adjusted until a pressure of between 50 and 100 psig was indicated on gage 15.

10.2.7 Switch 17 was then closed. Solenoid valve 18 was actuated and pump 19 started.

10.2.8 The pump continued to operate until a hydrostatic pressure of 18,900 psig was reached and a report was heard from within the chamber. The pressure at this time dropped and all attempts to increase the pressure failed.

10.2.9 Hand valves 9, 11, and 24 were opened and the system was vented.

10.2.10 All data were recorded.

10.3 TEST RESULTS

The specimen did not reach 24,000 psig during the burst test. Failure of the bonnet (cartridge) threads occurred at 18,900 psig (see figure 10-1).

10.4 TEST DATA

The specimen remained intact up to a pressure of 18,900 psig then the pressure dropped. The bonnet had separated from the lower valve body.

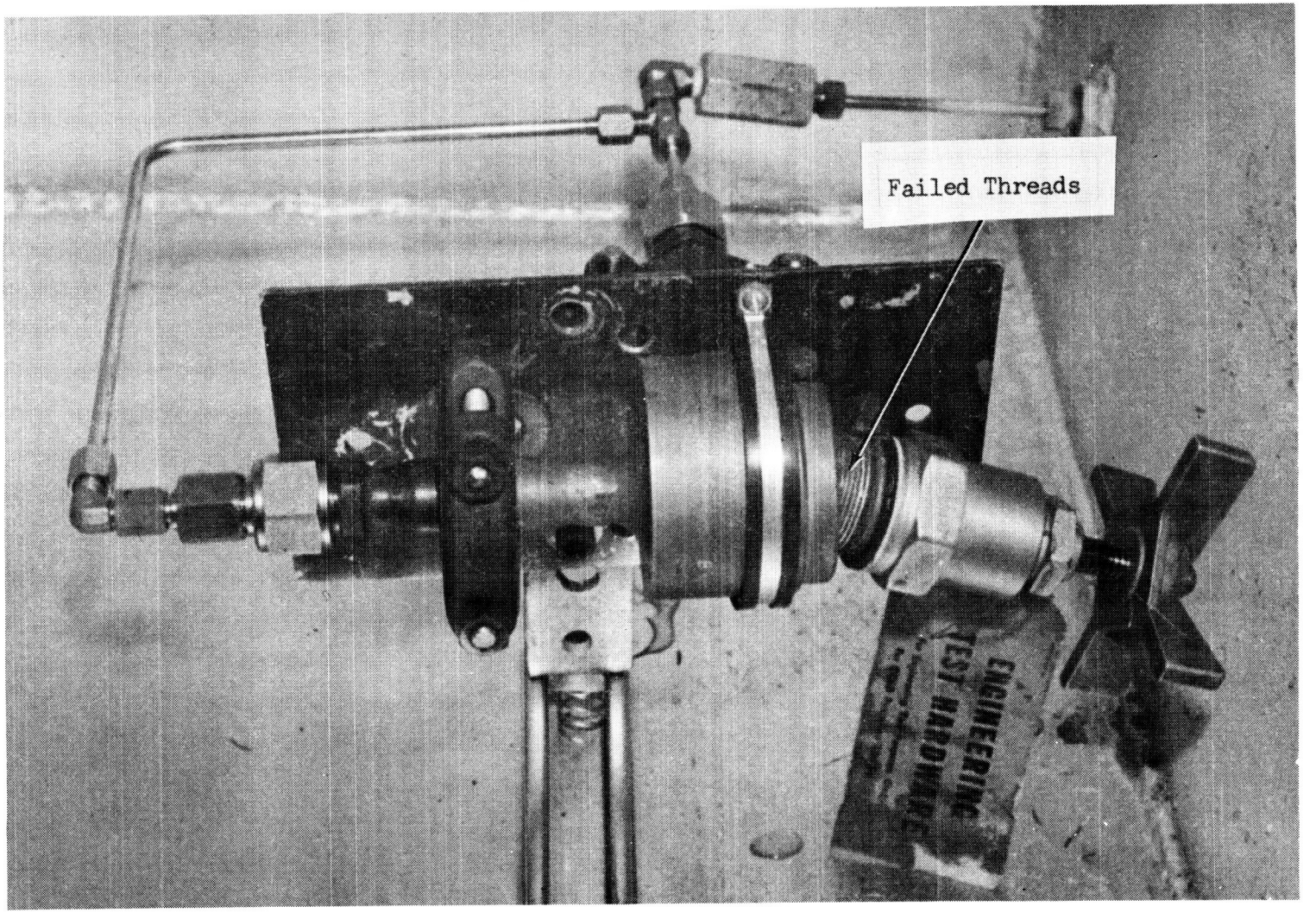


Figure 10-1. Burst Test Failure

APPROVAL

TEST REPORT

FOR

ANGLE VALVE, ½-INCH

Combination Pump and Valve Co. Model 371, Drawing Number C-6480

NASA Drawing Number 10428534

SUBMITTED BY

Darrell W. Miller

Darrell W. Miller
Test and Evaluation Section

APPROVALS

R. W. Claunch

R. W. Claunch
Program Supervisor

V. J. Vehko

V. J. Vehko, Director
Engineering Department

DISTRIBUTION

Chrysler Corporation Space Division

C. A. Brakebill	Test and Evaluation Section	2
R. W. Claunch	Program Supervisor, CCSD-Michoud	2
W. E. Dempster	Program Manager, CCSD-FO	6
E. J. Dofter	Chief Engineer, Reliability Engineering Branch	1
L. L. Gray	Test and Evaluation Section	5
P. Perani	Manager, Test and Evaluation Section	2
L. T. Scherer, Jr.	Manager, Data Center Section	1
V. J. Vehko	Director, Engineering Department	1

Technical Files	3
Technical Information Centre	1
Technical Writing and Editing Group	1

National Aeronautics and Space Administration

Marshall Space Flight Center

MS-IP, Bldg. 4200	3
APIC	1

John F. Kennedy Space Center

MD	1
MG	1
MH	1
ML, Mr. Fedor	1
RC-423	5

Scientific and Technical Information Facility 2
P. O. Box 33
College Park, Maryland 20740